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# Proceedings of Arcom Doctoral Workshop Research Methodology

Lloyd Scott
*Technological University Dublin*, lloyd.scott@tudublin.ie

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# Research Methodology

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Professor Lloyd Scott Dublin Institute of Technology

DUBLIN INSTITUTE *of* TECHNOLOGY

*Institiúid Teicneolaíochta Bhaile Átha Cliath*

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# Editorial

Welcome to this special doctoral workshop on Research Methodology which forms part of what is now a well-established support mechanism for researchers in the discipline of the Built Environment and more particularly construction management. The ARCOM doctoral series, around now for some seventeen years, has addressed many of the diverse research areas that PhD researchers in the discipline have chosen to focus on in their doctoral journey. This doctoral workshop has as an aim to offer an opportunity to explore and share research and the theoretical underpinnings facing PhD researchers within the construction and engineering sectors where the focus is on not just the topics of research but on the research approach underpinning that work. This workshop provides the opportunity for AEC researchers to come together in an environment where support for their approach to their research enquiry is offered by way of creating the correct conditions to share and discuss their journey. There is evidence to suggest there are many PhD students who would benefit from an environment where they can share their research phenomenon and this workshop session will allow for discourse and interaction to enable 'learning to take place' together.

In these proceedings are the seven final papers selected from some fourteen abstracts presented for review. It is important to recognize that the papers selected offer the opportunity for participants to learn from each other but also learn from the guidance of academics in the community who have a depth of knowledge around different methodological approaches. The process of selection for the workshop, while closely aligned with the ARCOM conference proceedings, is such that it is aimed at selecting papers within the scope of the topic but very much directed to allowing doctoral researchers' the opportunity to present work in progress where formative and developmental review can be offered through a constructive support mechanism. The context of each paper is diverse which has added to the richness of this edition of the doctoral workshop series. All papers have been peer reviewed and each author has had the opportunity to receive feedback and update/ improve their paper.

Alqatawneh's paper research through design as an approach to investigate design fiction insights and sees focuses on design fiction (DF) as an approach to speculation about the future using a combination of prototyping and storytelling, a type of scenario story telling if you like. They unpack the notion of DF through a link to its five criteria and principles, bringing together the notion of design - the capacity to imagine and make concrete products not yet in existence, and services for everyday life. This research employs research through design approach to investigate the functionality of fiction in design. Further, to explain the notion of design fiction and arising from using fiction in both design practice and design research the author defends the use of this methodology. Alqatawneh argues that the outcome knowledge is utilised to adapt and present fictional objects that suggest pathways to possible futures and sues the example of Self-Driving Vehicles to exemplify this.-.The author argues that DF offers the potential to consider far-reaching questions concerning the consequences of technological development while drawing attention to the social aspects and implications of techno-scientific solutions.

Colley and Scott address the philosophical positioning of functional contextualism as an approach to research conflict of interest in the real estate sector in Ireland. In examining the research question of good practice for managing conflict of interest in the real estate valuation process within Ireland a number of research methodologies were engaged with and considered. The author's proffer that once a review of literature in the field has been accomplished a central question arises for the researcher, that of a philosophical position so that the research can be addressed in what they suggest is the 'correct way'. They offer an overall pragmatic approach to the central issues of the formation of an individual's ethical viewpoint and behaviours, the nature of the ethical challenges faced within the real estate

valuation process and the possible frameworks that may influence an individual's behaviour going forward. Within the pragmatic realm they argue for a more focused lens of Functional Contextualism. Functional contextualists they suggest seeks to predict and influence events using empirically-based concepts and rules and this they contend addresses the research question suitably. Emphasis is placed on highlighting the areas of the approach that fit and also those that require omission due to their lack of suitability to the subject under investigation. Overall they make the case for using the most appropriate methodological position through correct grounding with research methods that allow the researcher to progress without 'conflict'.

Kelly in his paper addressing the impact of human cogitative behaviour and tacit judgement on the development and accuracy of cost estimates for pharmaceutical projects in Ireland and makes the strong case for researching this topic through the lens of 'more thoughtful research design'. He contends that 'more thoughtful research design' would get to the real reasons for cost overruns rather than using the convenient 'default responses' that continuously point in the wrong direction. He makes the case for a 'paradigm shift' towards the general use of the newer non-traditional types of building project contract price forecasting models and there is evidence that this has not been generally achieved. In considering his roadmap through the research topic he suggests the challenge with this proposed research is the adoption and justification of the research methodology. He argues for mixed-method research, methods that require positivist and interpretevist methods as well as multi-paradigm and multi-strategy approaches. The challenges, he contends, include the many different conflicts. For example how the researcher sees the world and the epistemological commitments needed which may cause confusion with the stated committed rules the research might follow and that will impact on the use of both positivism and interpretivism paradigms as well as qualitative and quantitative information.

Mdaanayka and Egbu in their paper explore innovative solutions in consideration of exploring the possibilities for improving the utilisation of digital technologies via integrating BIM, Big Data Analytics and Internet of things (together aka BBI )which has the potential to give organisations the long awaited competitive advantage. The study follows a mixed methodological approach which leads to investigate the critical factors that impact on effective implementation and exploitation of BBI for competitive advantage and thereby develop a strategic framework for improved understanding of such critical factors at play. They argue for mixed methods based on epistemological, ontological and axiological perspectives. The factors associated with the research, they argue, fall in to four main themes inter alia; organisational size, culture, structure and skills-knowledge-training needs. The latter will be demonstrated as a separate skill-knowledge-Inventory (SKI). Their philosophical stance is a combination of interpretivist and positivist. They argue for an approach that holds a mixture of inductive and deductive means in different stages as the study starts from literature review to develop the strategic framework consisting of critical factors. Their data collection methods in this study will be the use of semi-structured interviews in pilot study phase and questionnaire surveys in the main study phase. Focus group approach is intended to be employed to validate the framework and SKI. They make the case for mixed methods as the multidimensional constructs/ variable implications demand such methods.

O'Cleirigh deals with research within the construction industry which is primarily based on qualitative and quantitative methods but has the potential to include studies that combine both methodologies. The research review considers and outlines the various methods and the differing views of the purists from both traditions, while re-examines the 'war' between them

and thus proffers the arguments for and against using mixed-methods. O'Cleirigh also demonstrates that some commonalities and a relationship exist between quantitative and qualitative approaches to social science research and that his research explores that relationship in context to the construction industry. The author resolves to position mixed methods as a bridge between traditional qualitative and quantitative research. Discussion, he commends, centre on implications arising from the observation that, models upon which qualitative and quantitative methods are based, have differing philosophical views of real world research and consequently differing views of the research subject. O'Cleirigh strongly argues this positioning will aid advancement of industry knowledge by adapting methods used in academia through providing a robust framework, for construction managers, for designing and undertaking mixed methods research. He makes the point that mixed methods research will become increasingly successful as more construction managers study, use and spread the underpinning philosophy.

Opiya and Chan, address the topic of the need for affordable housing and make the point that it has in recent times become a prominent policy issue for countries across the world. Among various challenges to affordable housing sector is the failure of supply to keep up with this growing demand. Consequently, they argue it is unsurprising to find a wealth of studies that focus on supply-side concerns of accommodating increasing demand for affordable housing. Through their research they have found studies tended to emphasize the role providers such as developers, contractors and government institutions can play to improve capacity and capability in the production of affordable housing. The point they do make, because of such emphasis has meant the relative neglect on the demand side. In their review, consideration of the problem of 'demand' to identify fresh perspectives on understanding the challenges associated with affordable housing is called for. They make the case for opening the complexities of studying 'demand' by researching a range of disciplines. The case for inter-disciplinary research aimed to understand a complex problem. They make the point that from an economic perspective, 'demand' is often framed in quantitative terms where balancing supply and demand results from rational, technological choices made by individual actors in the marketplace. They go on to make the point that a linear approach to 'demand' runs counter to a sociological understanding, where the realization is produced by complexes of social practices. They exemplify this making reference to a linguistic turn, the etymology of 'demand' stems from the Latin phrase de mandare, which means 'to formally order'. They proffer from this 'demand' is not simply defined by exogenous forces of the market, but also raises questions as to how society is brought to order. Relating this position to the context of affordable housing, they make the case understanding 'demand' also raises the need to examine ways in which vulnerable segments of society are excluded from formally ordering their requirements. In this review, we will reflect on various perspectives of 'demand' to raise questions about power relations and the problem of building a more inclusive society through housing. While the methodological approach is partly addressed in the paper the authors argue for a methodology that can be adaptable to deal with the complexity that surrounds the various perspectives of 'demand'.

Abiodun and Egbu in their paper, Implementation of building information modelling (BIM) on construction projects, is increasing gaining global acceptance as government from various countries are becoming the driving force for its adoption. The purpose of this paper is to present the research methodology and method to be adopted for this research. They present the aim and the objectives of the research, a set of research questions and then propose an approach to move towards methodological positioning. The paper discussed the various

research paradigms and philosophical positions available to all researcher and position the research on one considered to be most suitable to achieve the stated aim and objectives of the study. The argument around their justification is well made and the paper further discussed the various research approaches, methods and strategies available. In each case, a position was adopted for the research and attempts were made to justify the position adopted. Abiodun and Egbu conclude by proposing a research design method to be followed that allows the researcher achieve the research aim and objectives but that is fit for purpose.

The authors of the papers are to be commended for taking the courageous step in sharing their methodological and philosophical positioning, particularly as novice researchers it can be daunting to 'put on work out there'. It is a pleasure to be associated with this important aspect of the work of ARCOM and the continued support for this type of 'scaffolded experience' for the novice researchers, as they make their own personal research journey, should be supported into the future! Finally, there is a need to address the gaps in methodological approach and allow researchers flourish and blossom by allowing them the opportunity to experiment within their chosen research domain.

> *"It is often necessary to take a decision on the basis of knowledge sufficient for action, but insufficient to satisfy the intellect."*
>
> Attributed to Kant 1724 - 1804

Professor Lloyd Scott, 09th March 2018

# RESEARCH THROUGH DESIGN AS AN APPROACH TO INVESTIGATE DESIGN FICTION INSIGHTS AND USES

**Omayma Alqatawneh**[1]

*University of Huddersfield*

Design fiction (DF) is an approach to speculation about the future using a combination of prototyping and storytelling. As such it brings together the notion of design - the capacity to imagine and make concrete products not yet in existence, and services for everyday life. This research employs research through design approach to investigate the functionality of fiction in design. Further, to explain the notion of design fiction and the arising from using fiction in both design practice and design research. Afterwards, the outcome knowledge will be utilised to adapt and present fictional objects that suggest pathways to possible futures like the Self-Driving Vehicle (SDV) as a critical shift that describes a technological leap forward, in later stages of this research. This paper attempts to highlight how design can be used to produce different forms of knowledge, depending on the epistemological stances to gain knowledge, then to explain how this knowledge could be used to present solutions, the validity of the data, and the research findings.

Keywords: Design Fiction, Science Fiction, Experience Design, Interaction Design, Research through Design HCI, Self-Driving Vehicle, interaction design research,

## Introduction

Engaging with the future is an essential part of design. DF is an approach premised on speculation about the future through a combination of prototyping and storytelling. Referring to science fiction (Sci-Fi), the imaginative storytelling that speculates about future worlds. The term DF was initially coined by science fiction writer Bruce Sterling (2009) and is defined as “the deliberate use of diegetic prototypes to suspend disbelief about change” (Coles, 2016). Sterling’s definition has multiple meanings: "deliberate use" refers to something people do with a purpose; “diegetic” means the magical power that invokes the scene and draws attention to small details that enhance believability; and “suspend[ing] disbelief about change” is a creative act that situates the viewer in a shared conceptual space.

DF involves the appropriation and manipulation of design and fiction, where design is a creative act to find solutions, and fiction is a technique to open up a discursive narrative space. It is notable that Sterling’s definition of DF emphasises its methodological approach,

[1] Omayma.alqatawneh@hud.ac.uk

whereas its functional features can be considered as a tactic to visualise incoming technologies by employing a narrative structure to place them within a probable scenario.

## Notion of DF

Since the definition of DF by Sterling's emphasises on the term 'diegetic prototypes,' to explain how the viewer might understand and relate these designs to fiction. This research focuses on the idea of 'suspend[ing] disbelief about change.' The author believes that DF can be used as a tool to prepare and present potential ideas that could serve societies and contribute to shaping the future. Dunne & Raby, (2013), agree that there is a significant difference between inviting viewers to 'make believe' and asking them to 'believe,' as viewers have to suspend their disbelief willingly. Thus, this concept generates the most room for aesthetic experimentation because it releases the design from imitating reality or generating the already existed objects. Indeed, asking the audience to believe what has been created can very quickly lead to hoaxes and deceiving the audience into believing something that is real is cheating. Therefore, designers have to avoid the irony that pretends to be real, and viewers have to suspend their disbelief willingly to enjoy shifting their imagination into a new, and unfamiliar space.

Fiction is usually associated with something being untrue or unreal. Bleecker (2009) states that there is a need to comprehend if DF is a fusion of fact and fiction, but does that mean DF is real and legible? Speculating and extrapolating? A reflection on how things are, and how they might become something else? Or is it exploiting scenarios purely to provoke debates? Sterling (2013) states that the difference between real and not real is small. DF scenarios "are fakes of a theatrical sort," not intended to deceive people, but more of a creative act that sets the viewers into a discursive space for a while then let them go. Likewise, DF objects are not real, because "real things are not entirely and permanently real" (Ibid). This assumption crystallises that the existing ideas, brought into existence because they were buildable, profitable and desirable in origin.

It is essential to clarify that DF is something that creates its own world through a story, these worlds might be products, ideas, or narratives; and being prototyped within that story to create discursive space, raise questions, and investigate about innovations. Knutz et al., (2014) suggest a strategy to understand DF as an advance theory for testing alternative designs for

society or for criticising existing ones. They explain that DF can be accorded five criteria: (a) “What if scenarios” as the basic constructional principle of DF; (b) the manifestation of critique; (c) design aims; (d) materialisations and forms; and (e)the aesthetic of DF.” By applying these criteria in six projects, Knutz et al., found that this strategy revolves around the idea that fiction may combine with reality in many ways in design experiments. In this context, it is worthwhile to consider that the idea of using the “what if” premise is to provoke thinking of ways forward, or taking an idea that exists in a raw state and thinking through what would happen if it were circulated.

## Operationalising DF

Understanding how to operationalize DF is a big challenge, as it's described a postmodern technique that opens a discourse about potential futures. To recognize 'the plausible and the preferable' that drive human curiosities to investigate and solve unanswered questions about the future, it uses fictional scenarios or props to explore and discuss human progress and the emergence of creativity. Eventually, this leads to an escalating need to keep up with increasingly rapid technological advances. Tanenbaum (2014), clarifies that there is some debate in DF over whether it is fiction about design, speculative design, or science fiction. It has remained somewhat up for grabs, as it uses narrative structures to create knowledge, investigate and communicate about the possible futures for technology. Reeve (2012), explains that the ‘up-and-to-the-right’ approach means there are various potential futures rather than one future that goes in one direction. Whereas the ‘scenario’ is a traditional design scheme linking to a future vision, DF could be a fusion of design practices, science fact, and science fiction, this combination transforming the materialisation of ideas into something new.

While design and design research do not concentrate on the world as it already exists but instead attempts to develop a description of existing elements, processes, and activities to investigate a better possible future. Grand & Wiedmer (2010) explain their concept about DF as “implies that the conceptualisation of design and design research as a practice and investigation field, which particularly focuses on the world as it could be, should be taken as the actual core for defining and practicing design research." However, design methods bring innovative strategies to envisioning scientific research (Ibid). Based on this, innovations can be considered as new combinations of old or recently acquired knowledge and technologies.

Furthermore, DF can interact with the viewers through possible world theory, which demonstrates by Markussen & Knutz (2013) that might be impossible to comprehend in the present. However, these “possible worlds” are established through “cognitive estrangement” (Raven and Elahi, 2015), or signs that convey to the viewers that they do not perceive their current time and place. DF depends on the 'diegetic prototype' as a gravity point in the design, with the ability to generate these suggestions, supported by the story elements to present an efficient logic. The audience may thus suspend their belief and consider the work as fiction. Whereas Tanenbaum (2014) illustrates that even if a product/idea is ambiguous or unfamiliar to the audience, it must follow a set of governing rules. Therefore, the viewer must not be suspicious of the design or the presented technology. Furthermore, the scenario that focuses only on technological superiority may lose its critical value because it will not be able to provide the provocation that DF can present. Similarly, user-cantered design practice situates the audience at the centre of the design process; it should remain as the central point in the narrative.

Hence, DF may be considered a genre of self-reflection, an early step in the design process, whereas technology affects more aspects of our daily life, and it is more about an experience. McCarthy & Wright (2004) call it the “felt life,” the universal emotions and experiences of people becoming a domain which requires consideration. The motivating shifts that have occurred in recent decades are a substantial change to how things are seen or defined, categorised, or quantified. Although this change is considered the hardest one to predict, it is essential to clarify that these technological improvements do not present a brand-new technology, but developed versions of the existing one and more integrated with the modern world.

Most methods of reflecting upon DF require either self-reflection or publishing in research groups, both of which engage users with relatively short fictions as part of the design practice (Dalton et al., 2016). While this affords insight, the issue is that many new technologies are designed for a global market. However, the technology commonly used is distant future, and this is what provides some of the more exciting and of the insightful conclusions. Today, many scientists, futurists, and designers are speculating whether they can form a deeper connection between science fiction and real-life science, whereas the emotional and imaginative superiority of sci-fi stories leads them to a broader understanding of the contours of the future.

DF can be utilised as a technique to anticipate opportunity and challenges. Auger (2013), presents different methods as 'perceptual bridges' between the audience's perception of their world and the fictional element of the concept. A key method Auger uses is called 'Verisimilitude: design fiction or design faction' that simulates 'what if' scheme. Whereas the speculation can take the viewer far away from the here and now, making the proposed design idea seems unreal, the solution occupies in the range of possibilities that fiction may provide to make the vision feels real. 'World Without Oil[2] (WWO)' is a pattern of 'what if' method, a fictional issue meant to shed light on a global oil shortage, presented an alternate reality gaming (ARG). The imaginative crisis aims to hear from the people by enabling shared environment and thinking about a common future. The narrative in WWO starts by sharing information about how this issue might affect the daily life of the audience like that gas prices rose which caused chaos. Where such details help to draw attention, the participants are not involved as roleplay; they are instead a real play. Although different possibilities of expression enhanced the engagement, the participants were free to express their reaction in the way they found it convenient, as if the fiction of the game is real. After absorbing the dilemma, the participants did not just think about change, and what their lives would look like, instead they start to make it real. This kind of experiment is aimed to prepare the audience to accept what the author calls it the 'new normal.'

What is demonstrated here is that DF does not pretend to predict the future; it acts as a service to aid an audience to be responsive to the discourse on the future. Pasman (2016) has presented and explained the possible potential and implementation of DF as a service design approach. Also, he indicates that DF could be a new and innovative direction for service designers to investigate and establish new services in a contextually rich and comprehensive way at the beginning of a design process (Ibid). DF does not focus on application, but on forming a rich discussion of 'what-if' scenarios between research groups or users. Dunne & Raby (2013) emphasise that DF is concerned with progress, considering that progress means different things to different users and markets.

## DISCUSSION

DF is not realism, but a concept that is forward-looking, and tries to explore the new kinds of objects and technologies that are needed to help reimagine the world beyond storytelling. As 'logic' plays the main role in Tanenbaum's analysis, Bleecker acknowledges that design

[2] http://writerguy.com/wwo/metahome.htm

fiction is about innovation beyond the usual ubiquitous ‘up-and-to-the-right’, and provokes, raises questions, and explores possibilities through the ‘small details.’ Blythe (2014) illustrates that DF proposes examining a distant future. However, scenarios are based in the present, relating to facts and constraints of current technology, abandoning the surrounding social and political environment that a design may exist in, and focusing on the object or experience through a narrow perspective of the world (ibid).

While future’s fiction implications and solutions emphasis on envisioning progress, a far-reaching future-oriented approach in need, concerning the consequences of the technological development. The self-driving vehicles (SDV) is critical shift investigating the future implications of current advancements in mobility. The SDV notion concerns how advanced intelligent machines could emerge to improve our life, rearrange our social engagement, and conduct the social and economic systems in the future. Apparently, the 'now' is automatically accelerated.

Indeed, DF has utilised design for debate to understand emerging technologies and to explore the social-cultural, and the ethical impacts could happen. While DF builds a prototype within a story world to create a discursive space that would raise questions, exploration, and innovation. This paper explores for the idea that represents DF as an approach offers a technical definition, describes the current developmental status, and reviews the benefits and technological requirements of autonomous driving; this support is based on design rules formulated by Hiroko Shiratori in her article 'Unusual Objects from Japan.' Shiratori argues that fiction in design need to have kind of function whether physical relations or kind of interaction; should be humane and for everyone; it has to be believable, contemporary, and desirable (Coles, 2016). DF involves the appropriation and manipulation of cultural forms of design as a creative act to find a solution, and fiction as a technique to enhance discourse, and answer fundamental questions how will these technologies evolve in the future? Moreover, how will they impact our societies?

## CONCLUSIONS

DF raises far-reaching questions concerning the consequences of technological development. In particular, DF draws attention to the social aspects and implications of techno-scientific solutions, utilises the techniques of fiction to examine the future of objects, define what their

impact might be and present a range of possible alternative futures. DF employs objects and devices in the 'real world' to observe how they might be used and how people might react to these new objects. Like Sci-Fi, DF often reveals more about current reactions, attitudes, and behaviours than it does about the far future. While experts are producing advanced objects for the public, technology must be adapted to how the public behaves and learns from them to develop these objects. Scientists have agreed that the global market not only needs to understand where people are today, yet at which this technology is driving the public's needs.

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# IS FUNCTIONAL CONTEXTUALISM THE APPROPRIATE METHODOLOGY FOR EXAMINING THE MANAGEMENT OF CONFLICT OF INTEREST IN THE REAL ESTATE VALUATION PROCESS IN THE IRISH PROPERTY PROFESSION?

**Lorna Colley[3] Lloyd Scott**

*Dublin Institute of Technology*

In examining the research question of the best practice for managing conflict of interest in the real estate valuation process within Ireland a number of research methodologies were considered. Review of literature in the field supports a pragmatic approach to the central issues of the formation of an individual's ethical viewpoint and behaviours, the nature of the ethical challenges faced within the real estate valuation process and the possible frameworks that may influence an individual's behaviour going forward.

Within the pragmatic realm a more focused lens of Functional Contextualism is considered. Functional contextualists seek to predict and influence events using empirically-based concepts and rules (Biglan & Hayes, 1996; Hayes, 1993b; Gifford & Hayes, 1999). This paper examines the suitability of functional contextualism as the primary research methodology for researching conflict of interest in the real estate valuation process within Ireland. Emphasis is placed on highlighting the areas of the approach that fit and also those that require omission due to their lack of suitability to the subject research problem.

## INTRODUCTION

In undertaking a doctorate of philosophy, one of the key lynch pins of the research, regardless of the subject area, is the selection of an appropriate and robust methodological grounding. "In considering the appropriate research design, researchers must consider (and make known) to which research community they believe they belong as well as the epistemological, ethical and ontological assumptions of their research" (Remenyi, 1998). Ideally there is existing research in your field that has been peer reviewed and accepted with the research community that can form a directional arrow on where to ground your own work. Even if this is the case, the true understanding of methodological theories and the appropriate application to the subject area, is challenging and often done to a surface level with a stronger focus on the actual research methods.

In considering my research project "Property Valuation Best Practice for Conflict of Interest Management: The Irish Experience" and the appropriate methodology, many difficulties have been encountered and considerable time used to find an appropriate home.

[3] 451520@dit.ie

The aim of this paper is to evaluate the current result of the journey through the research enquiry to date and to open this up for peer review and commentary.

## THE RESEARCH PROJECT

A fulltime PhD was commenced in September 2015 in the School of Surveying and Construction Management, Dublin Institute of Technology under the supervision of Professor Lloyd Scott. The project title is "Property Valuation Best Practice for Conflict of Interest Management: The Irish Experience" and the aim is to examine how the Irish Real Estate Profession deals with the issue of ethics and whether it is currently robust enough to manage the nuances of the Irish Property Market.

Key areas addressed in the literature review include how the Irish relationship with property evolved, what is the Irish approach to ethics generally, has the Irish political context influenced the approach to ethics on a societal level and has this fed into the property profession's approach, how are ethics managed and taught to the property profession internationally and the role of ethics education is also examined in current Irish real estate qualifications, the newly formed Property Services Regulatory Authority (PSRA) license requirements and the various professional body membership requirements.

In reviewing literature related to the property profession it is immediately obvious that it is very much a "doing" approach undertaken. However, due to the relative infancy of the industry as a research discipline, it is difficult to identify a common trend in methodological grounding and most focus is clearly on methods, which is in keeping with the industries "doing" nature. Diaz (1993) argues that real estate does not need paradigms to define its body of knowledge and its research effort. While paradigms help to focus research, they can also limit it. Real property is logically the focus of research and interest because of its immense importance in human affairs." However, in order to successfully structure a research project as substantial as a PhD and to ensure its methodological robustness, it is necessary to address this issue.

Considerable time has been spent familiarising with the various methodologies, understanding the conflicting essences of these approaches, aligning these to the key issues of the subject research project and weighing up the most appropriate route. A key concern is that a methodology is selected prior to full primary research commencement, to ensure methods used are in alignment with this paradigm.

## RESEARCH METHODOLOGIES

The starting point in selecting a research methodology, is to consider what your philosophical position is. Philosophy is a broad and daunting subject area, on which vast volumes have been written.

## WHAT IS PHILOSOPHY?

"Philosophy is concerned with the very materials of thought, with ideas and their foundations and asks fundamental questions about the nature of things." (Misak, 2016). It commenced with the works of Plato and Aristotle and is constantly evolving and being updated.

In grappling with the many disciplines within philosophy, it is necessary to become comfortable with the definitions and their meanings. "It is common place to make a distinction between the theoretical sub disciplines of philosophy – to which ontology, metaphysics and epistemology are normally said to belong – and the practical sub disciplines – with the main contenders being ethics and political philosophy." (Brinkmann, 2018).

"Epistemology is concerned with the questions of knowledge, how we know what we know and how we orient ourselves to what we do not know". It is a fundamental aspect of philosophy and it is necessary for all researchers to go back to the beginning essentially and query how it is that we know any aspect relating to the subject research. In relation to the subject project, existing literature reviewed the last twenty years of Irish property market but it was necessary to expand significantly on this to identify how the Irish property market came into being, how this related to the social and political environment at the time and how it is that we have come to the current time with the definitions, understandings and practices that we do. "Epistemology is the branch of philosophy that concerns the origins, nature, methods and limits of human knowledge." (Fellows & Liu, 2015).

"Ontology is the branch of philosophy concerned with being." (Brinkmann, 2018). Due to the nature of the subject project and the nature of the property market, the Irish experience and evolution of ethics within the property profession, this is very much a qualitative piece of work and it is correct to state that "No qualitative research endeavour is without ontological commitments." (Brinkmann, 2018). Metaphysics is often mentioned alongside ontology and can be simply defined as "after physics" and "Metaphysics represents a deeper inquiry into what objects, space and time ultimately are." (Brinkmann, 2018).

The relationship between epistemology and ontology is core to the research undertaken and has directed the literature reviewed "Epistemology is the philosophical theory of knowledge. All qualitative research projects embody ideas about what knowledge is and how it can be obtained." (Brinkmann, 2018) and formed the basis for a number of the key areas of primary research. "The ontological and epistemological bases of research are fundamental as they inform all research activities – notably, using and developing theory, which denotes what elements are related to each other and to context." (Van Maanen, 2007).

After considering how all of the aforementioned influences the subject project, it is natural that the issues of ethics at societal level and how the industry itself is governed arises. "Sooner or later questions about knowledge touch on questions about society, about ethics and about institutions and how they work" (ibid). The bulk of the literature in this area is professional documents and working papers which again underpins the "doing" nature of the issues at hand.

## THE METHODOLOGICAL OPTIONS

In moving forward in the methodological grounding, it is now necessary to consider the schools of philosophical thought and which would be most appropriate for the subject research. The main approaches are clearly laid out in the "Research Process Onion" by Saunders et.al. (2007) and it is from here that each was considered and loosely applied to the subject project to identify suitability.

Positivism "Holds that there is one objective reality, it is singular and separate from consciousness" (Greco & Sosa, 1999) and this approach is normally associated with the sciences. A basic example of this approach would be a medical experiment where the results are either positive or negative and the conclusion itself hinged entirely on this outcome. There is no room for interpretation, the conclusion is drawn from the output. In considering the

subject project, this approach appears incompatible. There is no clearly measurable quantitative output that the research aim or objectives can be determined by.

Anti-positivism "Stresses that social reality is viewed and interpreted by the individual according to the ideological positions of individuals." (Greco & Sosa, 1999). This paradigm involves accepting that there are no facts as such and that "Knowledge is personally experienced rather than acquired from or imposed from outside". (ibid). There are elements of this that fit with the valuation profession in so far as a valuer and the work they complete is undoubtedly a product of experiences and there is no absolute "fact" or right or wrong in this area however, there are universally accepted Rules of Conduct and the quantitative methods are not open to interpretation. The associated research methods such as personal interviews and participant observations are expected to form part of the work undertaken.

Following on from these, Critical Theory is relatively modern and is defined as "A school of thought that stresses the reflective assessment and critique of society and culture by applying knowledge from the social sciences and the humanities." (Greco & Sosa, 1999). The focus on changing society on the whole appears beyond the scope of this research. The associated research methods of ideology critique and action research do not fit within the research objectives.

Pragmatism can be defined as "An approach that evaluates theories or beliefs in terms of the success of their practical application." (Oxford Dictionary, 2018). There are essentially two competing schools of thought when it comes to pragmatism; one at Cambridge, US and one in Cambridge UK. Regardless of their areas of divergence, the core principle of "doing" is common. "Ideas are not representations or copies of how the world is but, rather, are tools with which we transform, engage with and cope with the world as we go about living our lives." (Brinkmann, 2018). The apparent freedom to mix research methods under the pragmatic framework is appealing as the subject research project, due to its complex nature, requires many methods in order to capture the current state of the art.

## RESEARCHER'S DILEMMA

Prior to commencing the research project, the entire issue of the researcher's point of view and philosophical leanings were believed not to be relevant and essentially would not require examination and consideration. Early on in the research process it became evident that this assertion was incorrect and that the identification of the researcher's philosophical approach or "voice" is one of the key milestones in the PhD journey. Despite this realisation, this point has caused considerable difficulty and to date may not be entirely resolved.

The core piece that is yet to be determined has arisen out of the research undertaken to date. In arriving at the project and in the initial stages, the view was absolutely a "black and white" one, that there is a correct way to manage conflict of interest in the property valuation process and that regardless of the reality on the ground and associated difficulties with this approach, the end justifies the means. However, in reviewing literature and meeting with various stakeholders in the process, it has already become evident that there are many viewpoints with legitimate reasonings and the current position is a result of a myriad of influences that reflect an imperfect reality.

This struggle between idealistic perfection and imperfect reality, has consumed much time and work and frustratingly appears to be a decision that the researcher alone has to ultimately resolve as the work is their own. There are conflicting elements within various methodological approaches that fit various elements of the work and the debate continues on

whether this is acceptable and a "best fit" approach is defendable or to continue exploring this area, despite time constraints, in search of a "perfect fit".

## MOVING FORWARD WITH THE PRAGMATIC APPROACH

Having considered all of the aforementioned, it has been decided to move forward in the pragmatic paradigm. In considering the qualitative nature of the research and the very practical nature of the industry being examined, pragmatism appears the "best fit".

The property industry itself was born out of the need for people to own or rent land for agricultural purposes, to construct dwellings and then to trade them and the same for commercial property along with the added dimension of ownership for investment purposes. This was a practical need that was serviced by doing. The structure of the property market itself within Ireland has been in existence in some form or other since approximately 1155. Its evolution and where we find ourselves from a regulatory and ethical position has been undoubtedly influenced by the political and economic forces. "As human beings, we exist in this world fundamentally as actively participating beings, and we know the world and its properties solely through practice." (Brinkmann, 2018).

"Pragmatists, dating back to American philosophers such as Peirce, James and Dewey in the late 19th century, argue that knowledge is about doing rather than seeing." (Brinkmann, 2018). This is a key concept in the subject research, while ethics and conflict of interest specifically can be very much a theoretical pursuit, when considering it in the context of real estate valuations, it must be based in reality. Lessons to be learned will be derived from the real life experiences of professionals in practice in Ireland.

"In How We Think, John Dewey (1910/1911) developed a five-step research strategy or investigation procedure – sometimes also referred to as "abduction"-according to which the investigator follows five steps toward obtaining knowledge." (Brinkmann, 2018). In considering the appropriateness of pragmatism and Dewey's approach, this five step structure has been applied to the subject research process. "First, there is the occurrence of an unresolved situational problem, which creates genuine doubt." (Dewey, 1910). The questions over conflict of interest management in the Irish real estate profession has long been anecdotally acknowledged but has never been formally documented to date. Through my own professional practice as a valuer, the various day to day difficulties with managing this complex issue became obvious, both within a large city based multi-disciplinary firm and also within provincial practices where the individual is multi-disciplinary as opposed to the distinct departments found in the large city firms. In moving into full time academia as a lecturer on real estate programmes, to both traditional third level undergraduate students and masters students with relevant practical experience, anecdotal evidence was apparent on the supposed irregularities over conflict of interest management specifically in the valuation process. In reviewing existing literature and professional guidance around the issue, there is undoubtedly genuine doubt over whether the current professional approach is robust enough and in line with other industries.

"Second, this is followed by a specification of the problem in which the investigator might also either systematically or more loosely collect data about the problem at hand." (Dewey, 1910). In refining the aim and objectives and arriving at a specific, robust research question, it was necessary to carry out informal interviews with industry professionals, representatives of the professional bodies and various stakeholders in the valuation process. The information provided at this stage further supported the doubt over the current system of management and

also provided a more rounded view of the complexities involved in addressing a possible solution.

"Third, the investigator, now equipped with a specification of the problem, by way of his or her creative imagination introduces a hypothesis or a supposition about how to solve the problem." (Dewey, 1910). An alternative framework is to be produced after identification of all the issues in Irish practice, views and experiences of professionals, comparison and analysis of four other industry's approach to conflict of interest and a review of how ethics broadly and conflict of interest specifically is taught in the educational programmes and continued professional development requirements.

"Fourth, the proposed hypothesis is now being elaborated and compared to other possible solutions to the problem, and based on reasoning the investigator carefully considers the possible consequences of the proposed hypothesis." (Dewey, 1910). The various stakeholders and their views will be collected and analysed on the proposed framework and any possible alternative solutions examined. It may be necessary to amend the framework at this stage should the results of this process identify it to be necessary. Due to the sensitive and emotive nature of conflict of interest and ethical conduct generally, already it is noted that some parties are more reluctant to change and to indeed, consider an alternative approach even in theory. That being said, some of the alternatives and criticism to the new framework may be routed in this and so in-depth analysis and consideration will be necessary.

"Finally the hypothesis is put into practice, as it were, through an experimental or empirical testing by which the investigator checks if the intended consequences occur according to expectations and whether the problem is solved or not." (Dewey, 1910). In research carried out to date, it is evident that an alternative approach will have to be tested in order to ensure a willingness with stakeholders to embrace it. Within some parties, there is a readiness to accept there is an issue but an unwillingness to accept that it can be resolved, if not entirely but then to a significant extent.

This final stage of Dewey's research strategy essentially supports the abductive concept which is paramount in pragmatism "Methodologically, the core of pragmatism is abduction – that is, developing potentially helpful understandings and explanations in uncertain situations that are tested to determine if the situation becomes more clear and workable." (Dewey, 1910). The methods by which this testing is to be carried out can be varied which suits the research project. "Without privileging any specific part of the methodological toolbox, with its emphasis on abductive procedures, pragmatism has proved very useful, particularly in explorative qualitative research as a framework for problem-oriented investigation". (Brinkmann, 2018). As opposed to the other paradigms such as positivism and constructivism which are based on induction and deduction respectively, the focus of pragmatism on a workable, real life solution to the problem is in keeping with the overall aim of the research project. "Unlike induction and deduction, abduction begins with a breakdown in our understanding of something and is oriented toward making the indeterminate more determinate in order to facilitate action (Alvesson & Karreman, 2011)."

One area of pragmatism which requires further consideration is the contention that a pragmatic approach is essentially a qualitative one and that quantitative work has no place in pragmatism. "The links between mixed methods and pragmatism are problematic and that advocates for mixing methods and pragmatism are problematic and that advocates for mixing methods do not always understand the philosophical underpinnings of pragmatism." (Brinkmann, 2018). Due to the quantitative nature of the real estate valuation profession and the possible need to include some quantitative analysis on the impact of conflict of interest on

reported valuation figures, can an argument be made for the inclusion of this work under a pragmatic approach?

## BEHAVIOURAL RESEARCH IN REAL ESTATE

Having accepted a general pragmatic approach is probably the most suited to the subject research, the next dilemma is which of the research disciplines does real estate belong to? It would appear, as mentioned earlier, that the vast majority of real estate research tends to avoid attaching itself to either a philosophical paradigm or indeed a research discipline so it is difficult to identify a clear pattern.

Conflict of interest is essentially an ethical issue, with a core focus of the research on how people perceive conflicts in a given situation and why do people following on from this behave a particular manner. Once this is determined the next stage is to consider how this can be influenced favourably going forward. The concept of human behaviour and an in-depth understanding around this area appears to be essential to successfully completing the research aim and objectives.

The relationship between the real estate profession and behavioural science has been examined to some degree by Diaz, Brown, Grissim, Black and Gibler (2000). They accept that there are distinct areas of real estate research "finance and traditional economics, expert decision making. Marketing and markets, spatial analytics, organisational behaviour and development and the legal and regulatory environment." But they also acknowledge that one of the major drawbacks in the field has been "Almost all behavioural investigation into the problem solving of property experts has been focused on valuers. This research can be broken down into four categories, departures from normative models, comparable sale selection, valuation biases and feedback." (Diaz, Brown, et.al. 2000). None of these are a perfect fit for the area of ethical conduct in a conflict of interest situation but elements of research carried out in all four categories are relevant to the subject project in varying degrees.

In research terms "the real estate asset is most often treated as a financial asset." which is the case in the context of this project but the financial element is not the primary focus but rather the human behaviour when valuing the asset and how conflict of interest is managed in this project. "One uniting factor of all these disciplines (finance included) is that they ultimately derive their existence from human behaviour." (Diaz, Brown, et.al. 2000). With this point in mind other methods may need to be considered alongside the more traditional ones used in real estate research "If every real property problem is seen as a finance problem, researchers miss the opportunity to use tools and thoughts from other disciplines." (Diaz, Brown, et.al. 2000).

## FUNCTIONAL CONTEXTUALISM

In trying to find a specific methodology under the umbrella of pragmatism that may provide a definite base for the subject research project, functional contextualism was suggested. It is almost a dual approach with a marriage of elements of pragmatism, as discussed above, and contextualism. "A modern philosophy of science rooted in philosophical pragmatism and contextualism." (Hayes, Strosahl, et.al, 2011)

Contextualism is associated with the work of Stephen. C. Pepper but is closely linked to the pragmatic work of Dewey, "Contextualism is Pepper's term for the philosophical pragmatism developed by Charles Sanders Peirce, William James, John Dewey and others." (Hayes, Strosahl, et.al, 2011). It is a relatively complex concept that is based on the acceptance of

"world hypotheses" or "world views" and that any analysis is valid "Insofar as it leads to effective action, or achievement of some goal." (Pepper, 1942). Contextualists argue that any world view is based on "a distinctive underlying root metaphor and truth criterion" (Pepper, 1942). A root metaphor is defined as "the act in context", whereby any event is interpreted as an ongoing act inseparable from its current and historical context." While a truth criterion is defined as "successful working, whereby the truth and meaning of an idea lies in its function or utility, not in how well it is said to mirror reality." (Pepper, 1942).

Within the approach of contextualism is the concept of functional contextualism. This follows on from pure contextualism but focuses very much on the action or function coming from the research "Functional contextualists seek to predict and influence events using empirically-based concepts and rules." (Hayes, Strosahl, et.al, 2011). The core concept is, nothing can be considered without reference to the context in which it occurs, which on the surface appears to be in keeping with the subject research and the assertion that the Irish valuer's psyche and structures of society may pose different challenges to the global conflict of interest best practice guidelines. "From a functional contextualist worldview, any thought can be either normal or problematic, depending on the context in which it occurs." (Hayes, Strosahl, et.al, 2011).

In considering how functional contextualism can add to the achievement of the research aim and objectives, it is necessary to consider the practicalities of how this approach influences primary research collection and analysis. The overall goal of influencing behaviour instead of merely identifying issues or patterns undoubtedly will require a more thorough approach in order to prove that behaviour can potentially be influenced. This ties back to Dewey's concept of abduction as opposed to induction or deduction. The most common research method used by functional contextualists is "Controlled experimentation: events in the context of the behaviour are manipulated in a systematic manner and the resulting effects on the behaviours occurrence are observed." (Hayes, Strosahl, et.al, 2011). This approach is something that has been discussed in relation to isolating the impact of conflict of interest on reported valuation figures, based on the premise that valuers, when informed that research is centering on conflict of interest, may put their "best foot forward" in this regard and ultimately what we are seeking is a chance to capture the realistic approach to this issue, in practice in Ireland. The use of controlled experiments where valuers are not informed of the purpose of the research, valuation problems are posed mirroring realistic client instructions with conflict of interest issues embedded within, there is potentially a better opportunity to capture the truth of the issue.

However, controlled experiments are one element of a myriad approach that at this stage have been identified as being necessary to achieve research aims. In investigating the compatibility of functional contextualism with a mixed methods approach, it was positive to discover that "While functional contextualists favour experimental techniques, they encourage the use of a diverse set of methodologies, provided that value is always measured against pragmatic goals." (Hayes, Strosahl, et.al, 2011). Another positive identified was "Group designs using between-subject comparisons can be employed effectively for the purposes of functional contextualism, for example, and even correlational or predictive research" (Hayes, Strosahl, et.al, 2011) and this may be relevant when considering the comparative approach to conflict of interest in the Irish property valuation profession and the four identified industries of fund management, medical, legal and corporate governance.

A concern however, still remains over the functional contextualist's view that mixed methods have a place but "Are not as effective as experimental procedures for testing the influence of environmental variables on behaviour or for verifying the general utility of principles."

(Hayes, Strosahl, et.al, 2011). Further consideration and exploration is required in order to ensure that this point can be successfully overcome when defending the methodological approach chosen.

## CONCLUSION

In order to decide upon the appropriate methodological grounding and associated research methods that are most fitting to examine the issues surrounding conflict of interest management in the valuation process within the Irish market, much work has been carried out. To date, functional contextualism has been selected as the framework within which to approach the research project but there are still potentially unresolved issues over the role of qualitative methods in addition to the more traditional controlled experiments which will need to be explored further before a definitive decision is made.

Another area for resolution is the researcher's own conflict over their idealistic beliefs and the real world practicality that appears to be required within the valuation profession. A question still remains over whether the work can be structured in such a way to allow for both these elements to be combined or does own distinct school of thought need to be aligned with.

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# A CRITICAL REVIEW OF THE IMPACT OF HUMAN COGITATIVE BEHAVIOUR AND TACIT JUDGEMENT ON THE DEVELOPMENT AND ACCURACY OF COST ESTIMATES FOR PHARMACEUTICAL PROJECTS IN IRELAND

**Michael Kelly**[4]

*University of Salford*

Research has shown that the extent of project overruns has not decreased in the last 70 years, and due to superficial, replicative and stagnated research on the subject, more thoughtful research design is required to get to the real reasons for project cost overruns. It has been shown that much of the literature on project cost overruns and their reasons, were largely inadequate and deficient to deal with the complexity of construction cost overruns and continuously point in the wrong direction. This practice-led research contends that the accuracy of project cost estimates are often not considered by studies as reasons for overruns and this research presents four significant reasons why project cost estimates can be flawed in their stated accuracy and therefore offer what Brandon (1982) sought as a "paradigm shift" towards the general use of the newer non-traditional types of building project contract price forecasting models and processes.

The research can be termed as action-based practitioner research where gaps in knowledge and questions derive from the author's experience and practice rather than 'mode 1 knowledge' which is disciplinary, theoretical knowledge generated in the academy for subsequent application in practice' (Chynoweth, 2013). The challenge of the research is to be capable of delivering academically rigorous and robust outputs relevant to practice. The complexity of construction cost overruns referred above is demonstrated through the need for the adoption and justification of mixed-method Research Methodologies that require positivist and interpretivist methods as well as multi-paradigm and multi-strategy approaches. Challenges include the conflicts on how the researcher sees the world and the epistemological commitments needed which may cause confusion with the stated committed rules the research will follow that will impact on the use of both positivism and interpretivism paradigms as well as qualitative and quantitative information. This 'practice-led' research will be concerned with the nature of the practice and management of design functions and so research of this style will be undertaken either in the natural or social sciences or in the humanities. Research into parametrics, estimate accuracy data and risk calculations will be undertaken using empirical investigations and in the scientific tradition or Nomothetic. It is expected that this will involve quantitative analysis of data and statistical outputs which challenges the positivist paradigm.

Keywords: axiology, deductive/inductive approach, epistemology, estimate accuracy, estimate classification, interpretivism, objectivism, ontology, positivism, subjectivism.

[4] michael.Kelly@nph.ie

**Background context**

The origins of this research come from the author's experience in the commercial management of major projects in Ireland where the application of established and prescribed estimate verification procedures, broadly based on the American Association of Cost Engineers (AACE) recommended practice for cost estimate classification, were used for defining the level of the estimate accuracy. These estimates and their prescribed accuracy levels became the basis of project cost budgets and were used as the baseline for cost management. These budgets set the limit of permissible expenditure against various elements and estimators are often loath to accepting that estimate error as a reason for any additional unforeseen funding required to meet the Basis of Design (BoD). The author has found little research that specifically points to estimation error for project cost over-runs and particularly to pharmaceutical projects.

Ahiaga-Dagbui and Smith (2014), referred to the distinction between cost over-runs and under-estimation and cited strategic misrepresentation, optimum bias, scope changes and lack of information reasons for underestimation with scope changes, ground conditions, technical, managerial issues and resource cost fluctuations as reasons for over-runs. Baccarini (2005) suggested that risks are not managed correctly with provisions made by estimation on an arbitrary manner using rules-of-thumb of contingencies using percentage allowances. Flyvbjerg et al, (2002) talked about strategic misrepresentation, lying and optimism bias where benefits are overestimated and costs are underestimated. These theories are perhaps correct for projects whose commencement is conditional on favourable budgets, but it is the author's experience that pharmaceutical projects are not often conditional on tight budgets and in many cases not created in a competitive tendering scenario. It can be suggested therefore, that there is latitude for the estimator to make errors and in the absence of controlling competition or in-house peer reviews of the final estimate outcome, project costs could be under-estimated or at worst, under-estimated but validated as correct.

Ahiaga-Dagbui et al (2015) sought to explain the reason of observations by Flyvbjerg et al. (2002) that the extent of project overruns have not decreased in the last 70 years, as due to 'superficial, replicative and stagnated' research on the subject. They contended that 'more thoughtful research design' would get to the real reasons for cost overruns rather than using the convenient 'default responses' that continuously point in the wrong direction. Ahiaga-Dagbui et al (2015) critical literature review on project cost overruns and their reasons, concluded that they were 'largely inadequate and deficient to deal with the complexity of construction cost overruns' They stated that 'Cost overrun in the construction industry has been attributed to a number of sources including technical error in design or estimation, managerial incompetence, risk and uncertainty, suspicions and foul play, deception and delusion and even corruption'. They did not expand on this with detailed research and the author believes that this presents a gap in knowledge for further investigation and in particular, investigation on the impact of estimate error.

**Problem Statement**

As per the observations of Ahiaga-Dagbui et al (2015), initial literature reviews have shown that project cost-overruns seldom blame the original project estimate. Study and interviews to date have established four avenues of investigation that can illustrate significant risks to estimate accuracy, but it is expected that as the research develops, further avenues may emerge. The challenge for this research is to develop a research methodology approach appropriate to proving the following contentions and their impacts;

1. The personal actions of the estimator during the estimation process often differs from estimator to estimator where the application, based on tacit knowledge, of factor-allowances and contingencies for unforeseen scope and risk are included. The author believes that variances between tenders have a lot to do with decisions made during this process and the social interactions that happen. The author believes that more study is required to look at the findings of Fortune and Birnie (2000) where human judgement was seen as a factor that affected the quality of the professional construction advice. They noted that the exercise of judgement was a human cognitive process and therefore was subject to errors, bias, and heuristic but there was still the question on whether this applied to intuitive thinking within their professional domain. A previous study by Fortune and Lees (1997) had questioned if learning style impacted on this. Fortune and Birnie (2000) explored the nature of the judgements made by professionally qualified consultant quantity surveyors using quantitative techniques and concluded, among other things, that more work should be undertaken with professional practitioners to consider if the presence of quasi-rational judgements found in the results of their study are replicated in actual real-life situations rather than in study simulations. This research requires and exploration of the human cognitive processes in place during the estimate decision making and whether these could have a greater than expected impact on estimate accuracy ranges. This will present a position on whether the human cognitive processes cited by Fortune and Birnie (2000) that may be in use, influence estimate accuracy or the hard strategic misrepresentation, lying and optimism-bias talked about by Flyvbjerg et al, (2002).

2. It is the author's experience that reliance on cost estimate classification guidelines, broadly based on the American Association of Cost Engineers (AACE) published categorisations, to categorise estimate accuracy level often leads reviews to regard the outputs to be too accurate to be the issue. This author makes the observation that whilst cost overrun data derives from hard comparisons between final costs and base budgets giving a hard percentage reading, the percentage accuracy of the estimate does not have the same such empirical basis. In fact, the percentage accuracy of the estimate is more of a personal opinion of its position in relation to expectation. This expectation comes from the level of maturity of the design information that the costs derive and falls more within a range of probability rather than a hard figure. It is the author's experience that this 'range' is not factored when directly compared to final costs and so its comparative conclusion can be flawed. For example, if a final cost overruns by 4% on an estimate that had a +/- 5% accuracy level, this could show a saving of 1% rather than an overrun of 4%. Furthermore, iIt is the author's believe that it is flawed to compare these two percentages as they represent different units, one is a hard empirical figure, the other an indicative position.

3. The author discovered during initial explorations, that estimates prepared broadly on the basis of the American Association of Cost Engineers (AACE) recommended practice for cost estimate classification, are not applicable to pharmaceutical projects and have been adjusted and changed by the major engineering and design houses. Discussions with the AACE have shown that there is no empirical data to support the percentage accuracies cited and they are in fact more geared to Oil and Gas projects rather than pharmaceutical. This puts into question the claimed percentage accuracy of the estimates and also notes that these percentage accuracies vary from Engineer, Procure and Construct (EPC) house to EPC house. For each level of estimate accuracy, the guidelines above refer to a corresponding level of design maturity required. The guidelines broadly outline the design deliverables expected in each phase but it is the author's experience that the exact design deliverables can differ from house to house and can also depend on the contract procurement strategy chosen. The estimate output from varying design deliverables can vary depending on the exact design deliverables issued to meet the design maturity. Much has been done to develop scoring procedures of estimate reliability in terms of bias measurement and variability using historical data from actual costs versus estimates. However, the author questions their applicability for one-off complex projects such as pharmaceutical.

4. Key to the successful estimation of unforeseen and unknown scope and environmental factors, is the influence on decision-making of personal bias and tacit knowledge. The application of tacit knowledge in applying a contingency in an intuitive manner, uses what Collins (2010), referred to as something that will 'link the person back to the society in which the judgement is embedded' This intuition is gained through practice and socialization and interactional expertise. Schon (1983) talked about the embedded skill where the self-consciousness of the process fades away and through reflection can turn knowing-in-action into knowledge-in-action. Contingency allowance will almost always be larger than the final estimate accuracy percentage and so the awareness of their calculation and the use of tacit judgement processes that go to forming them will be important. It is the author's experience that peer reviews of major pharmaceutical estimates seldom robustly question or even consider the possible impact of the estimator's personal human cogitative behaviour, flaws in tacit judgement and/or errors in the strict application or reliance for guidance on hard data / metrics. The non-regulated application of tacit judgement on the final estimate answer will differ depending on the human interaction in this process

## Methodology

The aim of the research is to demonstrate errors in reported estimate accuracy levels for pharmaceutical projects in Ireland and present as a valid reason to explain (or part-explain) project cost overruns. The contribution of this study could lead to better estimating practice and better project cost management. As a practice-led hypothesis, many of the author's contentions to date are under-pinned by opinion, observations and non-empirical results rather than a verified gap found through a literature review. It is therefore important that findings stand up to a robust academic defence with proper rational on the methodological choices

taken, otherwise it will fall victim to what Flyvbjerg et al. (2002) called another 'superficial' hypothesis. The research process the author intends to follow will require a systematic acquisition, understanding and demonstration of the body of existing knowledge at the forefront of the discipline and professional practice of estimating as well as a robust demonstration of its treatment. It involves research into all literature surrounding the question of accuracy, its relationship with design maturity, human judgement and cognitive behaviour, the nature of tacit knowledge and the reasons for project cost overruns. Systematic acquisition must also be rationally structured so that theoretical meanings that lead to robust theoretical perspectives that can generate a verifiable conceptual framework.

For the areas of estimate accuracy understanding, estimating processes, human judgement and cognitive behaviour, decision making and use of tacit knowledge, the research shall use mixed methods incorporating the design and development of questionnaires and structured surveys and interviews which will produce quantitative and qualitative data. It is expected that this will render rich data on perceptions of risk as well as information on social practices. Saunders etc al, (2016) outlined varying strategies including experiments, surveys, case studies, action research, grounded theory, ethnography and archival research. The author proposes to use a combined strategy of Case Study and action research.

Yin,(2009) suggests taking the organisation as the context and in order to give this a real world grounding, it will be important to understand the phenomenon in context. Analytical science philosophy with the use of interviews and case study, study the characteristics in a real-life instance for multiple cases in order to generate generalisable results. These results will generate theory on cause and effect which will provide truth. Further research to consider applicability of single versus multiple, embedded etc. With reference to Yin (2003), all data validation tests are yet to be developed and will include multiple sets of data on financial. Interviews, literature, questionnaires etc. The author proposes to use a case study to establish and validate the typical engineering workflow for a large-scale pharmaceutical project and by using real-project data, map the incremental contribution by each design deliverable to estimate accuracy.

The proposed research shall be an action-based practitioner research, capable of delivering academically rigorous and robust outputs relevant to practice. As such it could be termed synonymous with the notion of 'mode 1 knowledge – disciplinary, theoretical knowledge generated in the academy for subsequent application in practice' (Chynoweth, 2013). This 'practice-led' research is more concerned with the nature of the practice and management of design functions. It is suggested that research of this style can be undertaken either in the natural or social sciences or in the humanities.

It is hoped that the output from these will be an alternative paradigm for design maturity identification. Furthermore, the typology or taxonomy of the estimate data that shall be gleaned through quantitative analysis has yet to be designed. Further thought must be put to the sources of data and subsequently how the empirical phenomena can be categorised. This might also align with Seymour et al (1997) argument that favours interpretative or qualitative approaches rather than rationalistic or quantitative research approaches for construction management research.

In the development of theoretical foundations, the author expects to determine further research goals based on pragmatic determination as well as theory. Thus, observations shall be based on experientially gained tacit knowledge and detached observation. Flyvbjerg (2006) advocates practical wisdom and the study of organisations and organising with an emphasis on values and power and speaks of the concept of 'phronesis' 'Phronesis concerns values and goes beyond analytical, scientific knowledge (episteme) and technical knowledge or know-how (techne) and it involves judgements and decisions made in the manner of a virtuoso social actor' (Flyvbjerg, B, 2006) In this regard, this author's research will later need to consider the phronesis in action during the estimate appraisal process. The concept of 'episteme' would suggest looking at the theoretical know-how; the hard scientific facts or understanding and the body of ideas which give shape to the knowledge and would suggest what the scientific answer should be. Flyvbjerg (2006) advised that 'any attempts to reduce organisation research to episteme or techne or to comprehend them in those terms are misguided'

Trafford and Leshem (2008) outlined the need to synthesize detailed estimate data from activity level values into coherent and more simpler ranges of relationship 'packages' as a critical success factor of the thesis. An outcome that this author must safeguard, is, as Flyvbjerg discusses, 'an approach that exacts the general from the particular and then sets the particular aside as detail, illustration, background or qualification' which might leave us helpless in the face of the variance being explored. In the phenomenon of estimate inaccuracy, the author believes that inaccurate estimates are based on the sum of a large number of small mistakes which do not balance through probability. Research that focuses on the need to discover the one big question that explains all, may not be correct. In this regard, the author likes the phronetic organisation approach to make its departure in organisational micro-practices and searching for the big issue within all the small issues.

Subjective assessment of design input and estimate accuracy is very influenced on practice as well as data. How the estimator or decision maker interprets data and the practice and process of decision making is paramount. It can be seen that this can differ from the text or guidelines or discourse in the organisation. Flyvbjerg (2006) purports that the phronetic organisation research must be disciplined by analysis of the practice, practical activity and practical knowledge during the estimate situation. This can mean the sociological, ethnographic and historical phenomena that are occurring in the everyday estimating appraisal process. In his experience, the author has seen manipulation of estimate data and results in order to achieve the expected or required result. This might be despite the known fact that the data suggest otherwise. Flyvbjerg (2006) suggestion for the phronetic organisation research approach appears to fit perfectly into this scenario. He suggests that the researcher should attempt to 'understand the role played by single practices studied in the total system of organisational and contextual relations. If it is established, for example, that a certain organisational practice is seen as rational according to its self-understanding – that is, by those practicing it, but not when viewed in the context of other horizons of meanings – the researcher then asks what role this 'dubious' rationality plays in a further context, historically, organisationally, and politically, and what the consequences might be.

## Research Philosophy

With regards to the specific way in which this research proposes to develop knowledge, see the world and make assumptions, the research proposes to follow the structured headings in Saunders, Lewis and Thornhill (2016) 'Research Onion' to demonstrate the 'philosophical commitments' underpinning findings and in particular how the research addresses the specific philosophies, approaches, strategies, choices and techniques and procedures.

### *Epistemological Choices*

The epistemological choices available to this research depend on whether this research should view objects as positive data or resources or whether the it should consider the interpretative features of feelings or attitudes of the subjects being interviewed/questioned. In the case of resource research into the hard facts and explicit knowledge of hourly expenditure on design development, labour norms for activities of work, wastage factors, quantities of materials etc, which is akin to the natural scientist and far less open to bias and will be more objective, this research will adopt a positivism philosophy to a review of qualitative information in proving a theory. Research into parametrics, estimate accuracy data and risk calculations will be undertaken using empirical investigations and in the scientific tradition or Nomothetic. This will involve quantitative analysis of data and statistical outputs which challenges the positivist paradigm.

The author believes that it could be possible that Critical Realism maybe in action through the tone and reaction of the estimator when giving an estimate as competitive. Direct realism will be more applied when the full information on margin and risk are seen. Estimators adoption of a critical realism position, maybe derived from the social conditioning or the application of paradigms in the industry. The author must adopt a critical realist position in order to understand the structures, procedures and processes of the estimator's world and as per systems theory, understand their interactions and inter-relationships with one another. Once this is understood and outlined, any necessary change can be explained and accepted.

There shall be instances where the epistemological choice adopted by the research will be regarded as an 'interpretative' perspective. Construction cost estimates and resource allocation will at times derive from tacit knowledge requiring non-codified expertise or judgement. An understanding of what is happening in these instances will require more emphasis on the feelings and attitudes of the estimator./manager. This research contends that the question is far too complex to lend itself to theorising by some generalisation or law. Costs estimates require the estimator to unknowingly adopt two intellectual positions.

- A phenomenology position that will make sense of the world or environment in which he is operating
- A Symbolic Interactionism position that will process and interpret the social world in which the project is operating. The estimator will adjust and alter data based on an empathy with stakeholders and influences. These adjustments may not be readily identifiable through empirical data or material and so will require the research to enter the social world of the estimators.

In the case of this 'feelings' research, data resulting from social phenomena such as estimation of contingency allowances, risk factors, application of and factor-additions to parametrics, assumptions for economic trends to rates and future expenditures etc, which may derive from some external reality, will more than likely require a narrative presentation to explain.

*Ontological Choices*

The application of Ontology as a branch of philosophical study in the research, will be concerned with assumptions on how projects and teams will operate and why and how they make decisions. The researcher's view on this could be objective or subjective depending on the particular research aim. An Objectivism position may need to distinguish between the estimator as a product or creation of the social actors concerned with its creation and the estimators that actually inhabit that reality. Does the estimator, through his actions, create the process or culture within which estimates are produced? On the other hand, a subjectivism position suggests that the social phenomena in action when estimators manipulate estimates or make decisions without full information are created from their perceptions and any consequent actions of the social actors; that the estimator's actions are created from the environment, culture and process within which they operate. This ever-changing social interaction causes the process to evolve and revise. In understanding estimation decisions, it will be important to understand the reality working behind the estimating process. In other words, what are the subjective meanings that motivate particular actions by the estimator? The Social Constructivist view of reality will be that which is socially constructed. An example of this may be that estimators may see that material take-offs are always incorrect and so it is socially correct to make adjustments to allow for error. This is important to understand when varying stakeholders carry out peer-reviews of the estimate and make adjustments according to their perceptions of reality.

Theoretical versus practical approaches to culture and estimation practices fall within the objectivist-subjectivist position debate. The interpretivist position would suggest that it is necessary for the researcher to explore the 'subjective meanings motivating the actions' of the estimators in order to truly understand why decisions, actions and processes are taken. (Saunders, Lewis, Thornhill, 2016) This research will seek to adopt the subjective interpretative approach to understand the decision-making processes, risk-evaluations and attitudes towards accuracy that estimators take in order to fully understand answers and positions given. There are parallels with this approach and indeed, this formal research method. i.e Professional Doctorate and a doctorate looking at a question from a practitioner's viewpoint. The practitioner can best look at the context of a decision-making process and better understand the organisational culture and the many variables that impact on the decision-making process as well as the decision itself.

*Axiological Choices*

Axiology considers the judgements made about values, such as ethics and what may be important to the company or Client. This will require some social enquiry and so will need the author to articulate his own values and the basis of making judgements on data and in particular why one thing is important and not the other, why a certain choice of philosophy approach and why a certain data technique was chosen. Examples of this could be whether the author believes or not, that actions and decisions taken by the estimator are prudent, correct,

beneficial or otherwise to the estimate accuracy. This may affect an opinion on whether an action was pragmatic or otherwise.

Saunders etc al, (2016) refer to the concept of Research Paradigms to draw research philosophies together. They referred to the work of Burrel and Morgan (1979) and their categorisation of social science paradigms as a way of viewing real-life issues and problems and namely, radical humanist, radical structuralist, interpretive and functionalist. These categories look at the quadrant that the research falls depending on its conceptual dimension of radical change on one side and regulation on the other and on its position in relation to subjectivist to objectivist which have been considered above under Ontology. Saunders etc al, (2016) also noted that radical change critically looks at how business is conducted and suggests fundamental changes whereas regulatory perspective is 'less judgemental and critical'. This approach looks at how the affairs are regulated and seeks to offer changes within the framework of the regulations. i.e. changing the way things are done.

With regards to the use of the common understanding of design maturity levels and estimate accuracy measurement generally, the author suggests a social science paradigm that falls into the quadrant of fundamental change and a subjectivism position. Questions on Estimate classification, estimating processes and procedures fall into the Regulation paradigm and seeks to question the framework guidelines. The review on Subjectivism and the Social Theory on the decision-making processes can be classified as an interpretative paradigm that leans towards subjectivism and regulation.

**Research Approach**

The choice of Research Approach depends on whether it is 'deductive' where it is based on the development of a theory from some observations or 'inductive' where data is collected and a theory is derived from the results /data. Saunders etc al, (2016) observed that whilst deduction leans more towards the epistemological philosophy of positivism, and induction to interpretivism, this is not always the case. This author concurs that this research's preferred approach will be inductive-interpretivist and deductive-positivist.

Research looking at the impact of human cogitative behaviour, tacit judgement, the depth and significance placed on reference to estimate classification guidelines on the process of estimating and how this influences the accuracy of cost estimates for pharmaceutical projects in Ireland would be better served using an inductive approach using the following an interpretivist philosophy where a theory will follow data gathering and namely;

- understand the reality of the situation. This will involve interviews, questionnaires and the collation of qualitative research to understand the important characteristics of what is happening.
- develop a theory or make sense of what may be happening from this data,
- derive a hypothesis from this,
- make observations
- confirm / reject the hypothesis

A deductive approach may restrict explanations and especially when there are a number of variables playing on the decision and varying responses. However, the author will be using

deductive approach with structured quantitative data when applying a more scientific approach to data using hard estimating metrics and numerical data and therefore the research will use a combined deductive and inductive approach.

**Techniques and procedures**

To support the proposed strategies, this research shall use surveys, questionnaires and structured interviews. An analysis of real data from live and completed projects will generate quantitative and empirical data on design workflow hours and estimate accuracy percentages. These can be used to research risk and estimate accuracy. A review of the research objectives will lead to the methods of data collection and in particular,

– what data is significant
– where can it be found
– who are the stakeholders that hold data
– how much data should be collected
– how should it be accessed and
– how shall it be analysed

**Conclusion**

It is possible to collect data on estimated versus actual project costs and seek to generate a theory on estimate accuracy performance but final costs often if not always vary due to change orders, provisional sum expenditures, inflation, claims etc. Even if final costs could be reconciled with the baseline scope, the resulting output is only useful for estimates created outside of a competition environment. This still leaves the question on what is happening to create disparities. Variances on competitively bid projects tell the same story – this is, that carefully tendered projects based on set tender packages and scope, still can vary by a significant percentage. Therefore, research conclusions based solely on deductive theory and a positivism method will not address if Flyvbjerg et al, (2002) contentions of strategic misrepresentation, lying and optimism bias where benefits are overestimated and costs are underestimated are in action. This research methodology will require the development of theory using an inductive method from observations in practice, questionnaires and interviews and an ‘interpretative’ perspective and all within the authors stated epistemological commitments. The author believes that deductive reasoning must be used to prove the existence of a problem and gap in the process but that the possible source of the estimate inaccuracy problems is routed in the human cognitive behaviour and can only be illustrated through an inductive approach. Therefore, to focus toward one paradigm can cause entrenchment and ignorance towards a competing and alternate philosophical viewpoint. Mingers (2000).

The aims and objectives require the generation of data through empirical data collection as well as interviews and questionnaires. The Research Methodologies will require positivist and interpretivist methods as well as multi-paradigm and multi-strategy approaches which will

add hurdles to the demonstration of a robust treatment of the question. There will be conflicts on how the researcher sees the world and the epistemological commitments needed which may cause confusion with the stated committed rules the research will follow. This will impact on the use of both positivism and interpretivism paradigms, qualitative and quantitative information.

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# A STRATEGIC APPROACH TO EXPLOITING BIM, BIG DATA ANALYTICS, AND INTERNET OF THINGS (BBI) FOR COMPETITIVE ADVANTAGE IN THE CONSTRUCTION INDUSTRY: AN OVERVIEW OF THEORETICAL UNDERPINNING

**Upeksha Madanayu**[5]

*London South Bank University*

Besides the productivity and profitability hindering, the government of UK admits that the construction industry is lagging behind other industries in terms of fully utilizing digital technology. As an innovative solution to this end, consideration is now being given to exploring the possibilities of improving the utilisation of digital technologies via integrating BIM, Big Data Analytics, and Internet of things (together aka BBI ) which gives organisations the long-awaited competitive advantage. Many studies have provided different levels of insight into the achievement of competitive advantage. However, this study pitches organisational level (construction firms) as the unit of analysis and as the level of competitiveness. Given the role played by the construction industry in UK economies; as a GDP contributor, job-creator, shaper of the built environment and resource-consumer, the competitiveness of the construction industry is of interest majorly into firms. Hence, this study aims to unfold the theoretical underpinning of an on-going PhD study: investigating the impact of organisational size, culture and structures on effective implementation and exploitation of BBI in construction organisations. The study follows a mixed methodological approach which leads to investigate the critical factors that impact on effective implementation and exploitation of BBI for competitive advantage and thereby develop a strategic framework for improved understanding of such critical factors at play. These factors fall into four main themes inter alia; organisational size, culture, structure and skills-knowledge-training needs. The latter will be demonstrated as a separate skill-knowledge-Inventory (SKI). The philosophical stance is a combination of interpretive and positivism. The approach holds a mixture of inductive and deductive means in different stages as the study starts from literature review to develop the strategic framework consisting of critical factors. Data collection methods adopted in this study will be semi-structured interviews in pilot study phase and questionnaire surveys in the main study phase. Focus group approach is intended to be employed to validate the framework and SKI.

Keywords: Big Data Analytics, Building Information Modelling, Competitiveness, technology exploitation, Internet of Things, theoretical underpinning

## INTRODUCTION

The construction industry in the UK is currently facing uncertain market prospects between the political and economic conflict following the EU referendum vote (HM Government, 2017). The latest set of KPIs established by HM Government provides a valuable assessment of the industry's recent performance, its strengths and weaknesses, and its ability to accommodate evolving market conditions and improve compared to other sectors over the next few years (ONS, 2016).

[5] madanayu@lsbu.ac.uk

Notwithstanding, the problem appeared to be common in the global context as well. The construction industry is one of the world economy's largest sectors that employ about 7 percent of the world's working-age population with $10 trillion spent on construction-related goods and services annually (Economist Intelligence Unit, 2015). Despite the large share acquired in the world economy, the industry itself is facing intractable productivity problems being unable to withstand the dynamic changing climates of the global economic environment. Admittedly, 'infusing digital technology' has now been a widely accepted strategy to boost productivity and maximise the competitive edge (Chevin, 2017; Construction Excellence, 2016; Eriksson et al., 2017; Ive et al., 2004; PWC, 2015; Robson et al., 2016). It has now been hype that BIM (Building Information Modelling), BDA (Big Data Analytics) and IOT (Internet of Things) enabled strategy does have a significant impact on construction organisations competitiveness (Flanagan et al., 2007; Henricsson et al., 2004). Thus, this research seeks to answer the construction industry problems, considering BBI as strategic tools that enhance organisational competitiveness. Albeit there are benefits and challenges/ barriers that enable or impede their pursuance, it has now widely accepted that depending various conditions (i.e firm size, technological capacity, firm culture-structure setting, etc.) implementation and exploitation of BBI (collectively or individually) has the potential to offer firms with advantages towards competitiveness (Lu, 2006; Betts et al., 1991; Betts and Ofori, 1994).

The research itself introduces a conceptual framework initially with the findings of existing literature, encompassing the factors that highly impact on organisations ability to exploit BBI to maximise competitive advantage (Please Appendix-B) and establishes a range of hypotheses to test. These hypotheses emerge from reviewing the literature on the dynamism of technology in construction, competitive advantage of BIM/BDA/IOT and transformation power of digital technology (Alaka et al., 2015; Bilal et al., 2016; BIS, 2013; Etkin, 2016; Oyedele, 2016; PWC, 2015; Rathorea et al., 2016; Shah et al., 2015; WEF, 2016).

## AIM OF THE RESEARCH

To develop a framework for improved understanding and exploitation of BIM, Big Data Analytics and Internet of Things as strategic tools for competitive advantage in construction.

## OBJECTIVES OF THE RESEARCH

*Table 1: Nature of objectives*

| Research Objectives | Objective type | Type of data | Type of analysis | Method |
|---|---|---|---|---|
| 1.To critically review the state of the art in BIM, Big Data Analytics, and Internet of Things in the construction industry. | Qual & Quan | Qual & Quan | Qual & Quan | Review of literature |
| 2.To investigate the extent of use, exploitation, benefits, and challenges associated with BBI in construction supply chains | Qual & Quan | Qual & Quan | Quan | Semi structured interviews, Surveys |
| 3.Ascertain the impact of organizational size, culture, and structure on effective exploitation and implementation of BBI construction supply chains and the construction sector generally. | Qual | Qual + Quan | Quan | Semi structured interviews, Surveys |
| 4.Investigate the extent to which BBI are employed as competitive tools in other sectors (including Retail and manufacturing), and explore possible lessons for the construction industry. | Qual | Qual | Quan | Semi structured interviews |
| 5.To explore skills and training needs for effective exploitation and implementation of BBI for competitive advantage and, in this regard, develop skills and knowledge inventory (SKI). | Qual & Quan | Qual & Quan | Quan | Semi structured interviews, Surveys, desk study |
| 6.To develop and validate a framework for improved awareness and understanding of the critical factors at play in the exploitation and implementation of BBI for competitive advantage in construction | Qual & Quan | Qual & Quan | Qual & Quan | desk study |

### Research Questions

1. What factors impact on a construction organisation's ability to exploit BIM, BDA, and IOT for competitive advantage?- Require QUAL data (explore factors)
2. In what different and complex ways do construction organisations maximise competitive advantage through the exploitation and implementation of BIM, BDA and IOT?- require QUAN and QUAL data (investigate the correlations between factors and confirm the hypotheses)

## RESEARCH METHODOLOGY

Suppositionally, research methodology is the entire research process explained with justifications. This includes the assumptions of worldviews, research design, approaches employed, the strategy of inquiry, research methods, and validation techniques.

## Theoretical perspective

Howe, 1988, 1992 explains that linkage between research paradigm and research methods is neither sacrosanct nor necessary. Nevertheless, this research carries some linkage between paradigms and the choice of research methods. Brannen (2005) introduces 'three Ps': paradigms, pragmatics and politics as the foremost attention required philosophies, for a correct understanding of these shape a researcher's choice of method.

## Paradigms and Philosophical assumptions

Paradigm and philosophical positions define the limits the frame which the research or the researcher's frame of reference (philosophical assumptions- ontological and epistemological). The philosophical position is basically linked with ideas and their origins, in the ideas which drive the research and the ideals upon which research should be founded. Researcher's choice of methods is chiefly driven by these three Ps. Authors often mention the complexity and ambiguity of this paradigm as 'paradigm wars'. The philosophical positions for qualitative-quantitative strategies are said to be different.

## Philosophical Assumptions

A research question is often framed by epistemological assumptions influenced by the need to find theory that 'fits' a specific set of cases or contexts. In general, the two most dominating philosophical traditions for mixed method research are positivism and interpretivism. Qualitative researchers typically locate themselves within an interpretive tradition. However, there are times that they also hold realist assumptions about the world and the contextual conditions that form the perspectives of their study. In contrast, quantitative research is aligned to positivism, often by those defining themselves as qualitative researchers. Bryman (1988) rationalises this as most of the quantitative research does not pay much attention to epistemological and ontological assumptions in discussing their research. Moreover, the literature suggests another dimension of paradigms related to the transcendence of paradigms- micro and macro level perspective. Micro-level studies seek subjective interpretations while macro-level studies attempt at making structural explanations on larger scale patterns and trends and seek to pose structural explanations. However, it is likely that a researcher's choice of methods is highly ruled by the philosophical choices initially. Nevertheless, there is no agreement that the entire research process and context need to be governed by the pre-selected philosophical stance as the research unfolds (Brannen, 2005).

The researcher initially sees the problem need to be addressed in this research is an ideology between society and technology (Science). The society is either regulatory or subjected to radical change. In regulatory view, the status quo has framed the society to behave in such a manner regulated by a third party (i.e. Government, religion etc) and evolvement of the society is too often justifiable by logical means. To that end, every human is considered to be uniform and cohesive (modernism). In radical view, a constant conflict is seen as humans attempt to live a preferred life free from the domination of societal structures (post-modernism). On the other hand, the evolvement of technological science can be either a subjective or an objective approach to research.

*Epistemological perspective (how knowledge is constructed)*

The research explores the existing body of knowledge (theories related to competitiveness, strategic management, organisational culture, organisational structure, innovation and change management). By comparing and contrasting each theory, the researcher identifies the combination of theories that best suits the research context (innovative technology exploitation). The technological science is viewed in both subjectivism and objectivism. The qualitative data collection (interviews) seeks to explore the subjective side of real human perspectives being more interpretivists while the quantitative data collection seeks straightforward scientific decisions being more positivists. Therefore this research is viewed in both positivistic and interpretive lenses. Interpretive worldview helps the researcher to understand the role of people, technology and their interrelationships within construction organisational contexts. Researchers focus on the socially constructed nature of reality and the situational constraints of the contribution of digital infusion to firms' competitiveness. Hence, this research follows a qualitative approach based on interpretivist epistemology. Qualitative data collected are considered as subjectivist, and corresponds to 'ecological validity', which stresses on understanding how different realities are constituted in a localised context (Dainty, 2007). Through the positivist worldview, the researcher attempts to reduce the field of inquiry, focusing on some specific areas to gather quantifiable data. A series of questions were asked from sample population inter-alia the factors that impact on firms ability to exploit BBI, skills and training need related to BBI etc. Moreover, casual relationships are discovered such as the relationship between a managers' experience and the skills/knowledge dimension that he thinks as important. The [positivist worldview allows the researcher to derive quantifiable measures of variables by testing the hypotheses and draw inferences about a phenomenon from the sample to a stated population.

*Ontological perspective (conception of reality)*

The nature of reality (ontology) in this research is considered to be an existence relative to the theorised parameters. For example, the researcher believes 'competition' among organisations actually exits; only if it is viewed against the benchmarks (national productivity measures, etc). The researcher seeks to explore what makes some firms to perform better than others. On the contrary, the researcher believes the reality is also objective and ''out there" waiting to be discovered, which exactly the main purpose of this research (unfold the secrets of success from big players and help/ guide the majority of SMEs to reach the competitive edge). Knowledge captured by the industry professionals are stored, analysed and communicated by converting the knowledge into understand format. The researcher believes a human as the controller for everything. Even though we see employees are controlled and confined by a structured set of rules, the rules itself are also defined by a human. Therefore, the research strongly believes the dynamic capabilities and core competencies of human as the basis for this research. Moreover, this study complements constructivist ontology (or subjective) believing that objects of thought/social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence. The researcher sees the concept of 'competitiveness' would not exist without the social interaction and therefore in a constant state of revision with the involvement of key players/ actors in it.

It is manifesting the consideration of multiple realities in this study. Since the epistemological perception is inextricably linked to ontological perspective, the positivist epistemology is

linked to the objectivist ontology whilst the interpretive epistemology is linked to the constructivist ontology. This re-justifies the need for the mixed methodological approach.

*Axiological Position (domain of values and ethics)*

Value of knowledge is achieved by testing the value it creates to humans and to the world viewed as environmental settings. Since the unit of analysis is 'firms', this is achieved by investigating end users' views and opinions through qualitative and or quantitative means to better assess the value of the stated dynamic digital capabilities (BBI) viewed as a collection of assets, processes, and performances (APP approach by Momaya and Selby, 1998).

*Pragmatics*

Bryman (1988) suggest that researchers need to be underpinned by pragmatism as much as it is underpinned by philosophical assumption if they are meant to apply in practice. This implies that for research question formulation pragmatism is equally important as philosophical assumptions. Unlike in paradigms, the pragmatist is more to open up the world to social inquiry and the practicality of the research to meet practical and policy ends. Thus, the pragmatist is less-purist in terms of methods and preconceptions (about theory and method). Pragmatism entails current meaning or instrumental or provisional truth value of an expression is to be determined by the experiences or practical consequences of belief in or use of the expression in the world (Durkheim and Murphy, 1985).

In this research, organisational behaviours- which are generally positioned in complex and pluralistic social contexts demand analysis that is informed by multiple and diverse perspectives. Therefore, it can be rationalised that mixed methodological strategy was selected for the sake of strengthening the inferences. Moreover, to answer the research questions it requires a breadth of vision, tolerance and a willingness to accept different approaches and objectives instead of conformity. This attributes that there is no one correct method of finding what makes firms more competitive but many methods. Pragmatic rational for the research also can be discoursed by the resources available to researchers and the selection of questions required to be asked and the way they are framed. Because the actual cultural setting within a construction firm is impractical to observe, the researcher decides to use self-completion questionnaire surveys. Pragmatism is also associated with the level of the feasibility of particular methods. This research intends to employ semi-structured interviews with senior managers who generally considered to be the strategic decision makers of a firm. The senior managers are usually in powerful positions within a firm and their perspectives are likely to be (or be believed to be) unique within an organisation. For this reason it is pragmatically justifiable to use semi-structured interviews to capture their perception.

*Politics*

The politics of a researcher often explores the forms of knowledge and to whom that knowledge targeted on. In this case, views and perceptions of organisation managers are studied. Therefore one target audience is 'senior managers' who make strategic decisions. Moreover, up and coming scholars and educational leaders may also benefit from the implications. It is an ongoing debate that knowledge cannot be easily accessed and captured in terms of views, perceptions, and attitudes, albeit attempts are made through interviews and

questionnaire surveys (mixed methods) assuming that the collected data are a true reflection of them. Moreover, since the area concerned in this research is relatively under-researched and that makes the political rationale to explore the managerial views through explorative qualitative methods while choosing surveys to confirm the relationship between several cultural norms and their ability to maximise competitive edge.

**Research Strategy/ design**

According to the **Error! Reference source not found.**, the research objectives manifest both qualitative and quantitative natures and in order to fulfill the objectives, both qualitative and quantitative data need to be collected. Further, inspecting the two research questions it is also apparent that both QUAL and QUAN data are required to answer the two reserve questions. Subsequently, considering the outcomes of each objective, they are required to be analysed in both qualitative and quantitative methods are employed in this research. Teddlie and Tashakkori (2006) asserts research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry are 'mixed method research'. Therefore this research follows a mixed-methodological (MM) approach as the main strategy. This is also referred to as multi-strategy research (Bryman, 2001).

The basic reasoning behind the selection of mixed-methodological approach is as follows: According to the research aim, it is required to develop a framework for improved understanding of the subject area. In order to develop a framework, it is required to have a finite number of factors systematically selected. To derive the factors (impact factors-independent variables and implementation/exploitation factors, competitiveness factors-dependent factors) it is imperative to explore and understand how BBI is used (if at all) in the context of construction firms- the unit of study. In this study, the aforementioned three technological innovations (BBI) are treated as dynamic digital capabilities comprise with a collection of assets, processes, and performances (according to APP approach suggested by Momaya and Selby, 1998). The social problem investigated here is 'how construction firms achieve competitive advantage through the exploitation of BIM, BDA, and IOT''. How individuals or groups ascribe to this social problem is explored qualitatively. These qualitative data is typically collected in the participant's setting where collected data are inductively attributed from particulars to general themes while the researcher making interpretations of the meaning of the data. This approach allows the researcher to be more flexible with the stories heard from individuals to honour an inductive style, a focus on individual meaning, and the importance of rendering the complexity of the situation. The researcher intends to gather critical factors qualitatively to aid quantitative study. The reason why these factors solely obtained from a review of literature is that the subject area studies here is new and the paucity of already published empirical data. Therefore, exploring the problem in the current context is a prerequisite for producing the quantitative information.

The main purpose of the quantitative study is testing objective theories by examining the relationship between variables. Once the general themes are finalised through the qualitative study, it aids to develop the quantitative study with a set of finite variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures. This approach involves assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations, and being able to generalize and replicate the findings (Creswell, 2009).

A major advantage of MM research is that it enables researchers simultaneously to ask confirmatory and exploratory questions, and therefore verify and generate theory in the same study. MM strategy also encourages thinking 'outside the box' (Brannen, 2005) as well as generate new perspectives and innovative insights. It allows to fit with the political currency accorded to 'practical inquiry' that speaks to policy and policymakers and that informs practice (Hammersley, 2000). In receiver's perspective, MM strategy allows a researcher to speak to the audience in more than one language. Considering the emphasis of dissemination, it is vital to speak in multiple languages in a society where a growth of strategic and practically oriented research which meets the needs of users is at hype. This may be technical language that pitches the experts and a language that is easily communicated as well as easily understandable by the general public. On the other hand, words and numbers for everyone. According to Teddlie and Tashakkori (2006), it is important that the researcher must select a suitable typology specifically in Mixed Methods Designs. Because typologies help the researcher to decide the ideal path to accomplish the goals of the study among a variety of alternative paths when designing MM studies. The subsequent paragraphs describe the seven criteria that have been used by many authors in deciding typologies in MM design.

**Research methods**

Empirical data was gathered through the following research methods/techniques:

1. Documentation analysis such as BIM/BDA/IOT implementation strategy documents, written policies and procedures, and project documents, systematic reviews of scholarly articles.
2. Semi-structured interviews with different stakeholders (predominantly strategic managers in firms of four sectors according to SIC-2007 industry classification)-Those interviews are recorded and transcribed
3. Questionnaire survey targeted managers of three levels (strategic, middle and junior level) construction firms (according to SIC-2007 industry classification)

**Logic of inquiry (research approach)**

In general, surveys are meant to associate with inductive and deductive logic while qualitative methods are most often elaborated with a grounded theory where ideas are tested as well as generated. In this study, both deductive and inductive approaches are used for different stages.

The research starts with a comprehensive literature review to explore the existing theories. A broader view of general theories helps to narrow down to more specific hypotheses. This shows deductive nature in the first stage. In the second stage, the research holds more inductive nature as it moves from specific observation to broader generalisation and theories. Data collection starts with qualitative interviews, which shows the inductive nature of identifying concepts. The correlations between factors identified from the broader literature are further explored to establish a theory. Further, it uses identified concepts and investigates relationships; which deductive. The theories built are interpreted as a strategic framework and a Skill Knowledge Inventory (SKI). The relationships between concepts (the proposed theory) are tested by looking for facts that support or deny the suggested relationship (deductive)

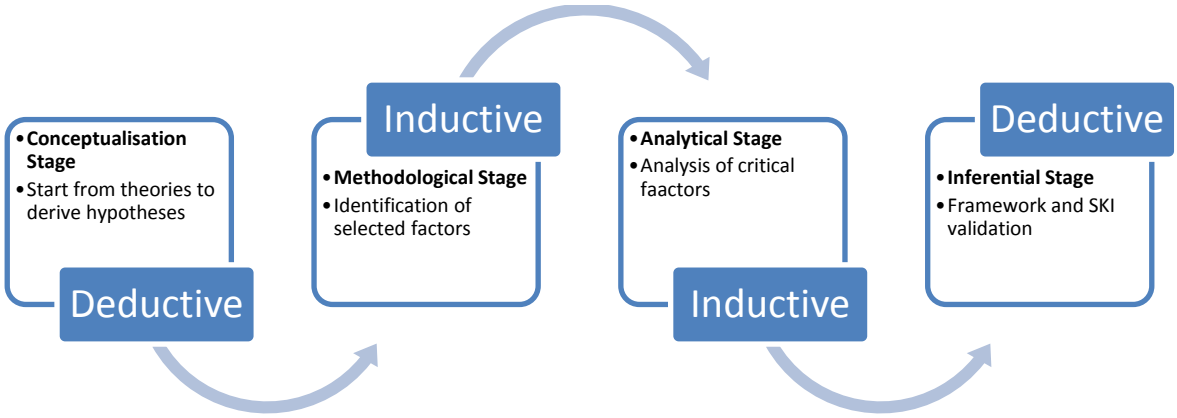


*Figure 1: Deductive/ inductive approach*

**Number of methodological approaches used**

To more specifically locate the MM design related to this research within the larger framework of a general typology of research, two methodological approaches are used. One Qualitative and one quantitative method are used. Hence, this research shows characteristics of a mixed-method design where QUAL and QUAN approaches are mixed across the stages of a study.

**Number of strands or phases**

A strand of a research design is a phase of a study that includes three stages: the conceptualization stage, the experiential stage methodological/analytical), and the inferential stage (Teddlie and Tashakkori, 2006). Considering the nature of research objectives, the research needs to be conducted in two phases for each method (QUAL and QUAN). Each encompasses all of the stages from conceptualization through inference. Therefore, Multi-strand Design is the approach selected.

**Type of implementation process**

It is apparent that some of the data collected from the qualitative method are required to be converted and fed into a quantitative method. Therefore, both methods occur in chronological order with one strand emerging from the other. Hence, it is a sequential design consisting of two strands for each QUAL and QUAN methods. The conclusions made as a result of the first strand lead to the formulation of questions, hypotheses, data collection, and data analysis for the next strand. The final inferences are based on the results of both strands of the study. The second strand of the study is conducted to confirm/disconfirm the inferences of the first strand. Moreover, each strand is further used to provide an explanation for findings derived from each opposing strand.

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*Figure 2: QUAL-QUAN strands and integration*

In light of this research, qualitative study is intended to precede (conducted first) as semi-structured interviews. Results from these interviews are then used to generate a series of

hypotheses related to this phenomenon. The semi-structured interviews in the first part of the study that examined several research questions. The resultant data are analysed using grounded theory techniques and derived set of hypotheses and critical determinants of several key impact factors. Based on these analyses, a series of 12 hypotheses were developed and tested using a 75-item questionnaire generated for the purposes of this study. Hypothesis testing involved both correlational and analysis of variance techniques.

It is said to be less common for qualitative research to be done as a follow- up to quantitative study (Ritchie and Lewis, 2003; Sieber, 1973). For highly resourced quantitative methods to initiate first, there should be a good and strong justification (Neuman, 2011). Hence, in this study qualitative method (secondary- less resourced) is conducted first and the quantitative method is conducted secondly (main-highly resourced) [qual > QUAN]. The level of dominance is explained in subsequent paragraphs.

**Stage of integration of approaches**

Collected QUAN and QUAL data are integrated into several stages. Therefore it is partial integration (not full integration at every stage). The results derived from QUAL study is transferred into every stage in QUAN study (Conceptualisation, methodological, analytical and inferential). Moreover, during the conceptualisation stage of QUAL study, the formulation of the QUAL oriented questions informed the formulation of the QUAN oriented questions.

**Priority of methodological approach**

In this research, QUAN method is treated to be dominant (main) while QUAL method is treated as secondary. Therefore lesser resources of time are being devoted to the QUAL method in terms of data collection and also in the analysis phase and the writing up while much resources are dedicated to QUAN research data collection, analysis and writing up. (qual > QUAN). The qualitative method also partially acts as a ‘pilot ‘questioning to develop coded questions for use in a survey. However, it is inevitable that the plans made at original design may subject to many changes with the progress. Therefore the research design counts not only the initial plans but also the changes to be made in the course of the study.

**Function of the research study**

Triangulation is when different bearings are taken in to research design where each complements each other in order to arrive at a precise physical location. The second bearing is not used to check or verify the first bearing (Brannen, 2005), This is also termed as a check, validate or corroborate one another in many research. This necessarily does not need to be combing different methods, rather can be using same observation (same method) in different settings or different vantage points (investigator, location, target group).

Complementarity is carried out when qualitative and quantitative results act as enhancers for each other while they are treated as different beasts. Ultimately, the data analyses from both beasts are juxtaposed and generate complementary insights that together create a bigger picture.

Initiation is used when the main function of the first method is to emerge new hypotheses, critical variables or research questions that can be pursued using a different method. This

research uses initiation as of the first method (QUAL) method is used to identify and define critical variables that are continued to pursue the criticality in QUAN method. This is also termed as development by some researchers as the analysis of first method sparks the development of second method.

Elaboration or expansion is often employed when there is a requirement for the data analysis of one method to exemplify the data analysis of other. Further clarified, it is one type of data analysis adds to the understanding being gained by another. In this research elaboration and expansion in QUAL analysis is also used to elaborate how patterns/trends based on quantitative data analysis apply in particular cases (firms).

Contradictions are applied when qualitative and quantitative data findings conflict. Scrutinising the contradictions between different types of data that are investigated to examine the same phenomenon is often interrogated with each other and one method is discounted in favour of another (in terms of assessments of validity or reliability).

Even though the exact function of the research is hard to assume at the first place of designing the research, it is presumed that the function of QUAL method is basically initiation/ development and elaboration and expansion, while the function of QUAN method is to confirm or reject the hypotheses and lead to framework and SKI (Skill and Knowledge Inventory) development.

Considering the typologies explicated above, this research follows a mixed-method, multi-strand, sequential methodological approach with partial integration where QUAN method dominate over qual method and qual method is conducted first while QUAN follows up. (qual > QUAN).

**Contextualisation**

The research topic does not specifically state that question intended to answer through this research is in the context of United Kingdom. In fact, the problem investigated here is common to global; therefore the inferences and implication made in the conclusion may be applied in different contexts in terms of nations. However, for the feasibility and viability selections, the researcher selects the United Kingdom as the context of data collection and construction organisations (generally) in United Kingdom as the 'unit of analysis'. Nevertheless, the researcher, through this research makes attempts to 'conceptualise' a phenomenon within a pre-defined context (UK) that can be applied to a wider context other than which the study is investigated.

**Credibility and validity of research**

The research employs focus group method to validate the strategic framework and Skill Knowledge Inventory.

**Quantitative and Qualitative studies used in this study further explained**

*Purpose of less resourced (secondary but firstly conducted) qualitative study (qual)*

Threw up hypotheses

- Threw up hypotheses
- Way of establishing significant variables for isolation and examination (See Appendix A)
- Resource area is under-researched, hence explorative
- Act as a 'mapping' exercise to inform the research design and implement the quantitative part of the study.
- Strengthen some interpretations in the inferential stage.
- Describe, in rich detail, phenomena as they are situated and embedded in local contexts.
- Identify contextual and setting factors as they relate to the phenomenon of interest
- Determine how participants interpret "constructs'' (variables) and allocate them according to the priority given by them.

*Purpose of high resourced (main but secondly conducted) quantitative study (QUAN)*

- QUAN tradition is employed with hypotheses predicting via significant relationships between several predictor variables.
- Reject or confirm the qualitative evidence.
- Testing and validating already constructed theories and hypotheses about how (and to a lesser degree, why) phenomena occur- How construction organisations maximise their competitive advantage by exploiting BIM, Big data Analytics and Internet of things as strategic tools.
- Generalise research findings when the data are based on random samples of sufficient size- the organisations that are good at BIM may not be good at BDA or IOT. Thus, random sampling can be justified.
- Elaborate the cause-and-effect relationships- the research investigates the level of impact of impact factors for competitive advantage using BBI as strategic tools that drives competitive advantage.

## CONCLUSIONS

This paper summarised the research methodology along with the theoretical underpinning for an on-going PhD study. The paper highlighted the philosophical foundation of the research and the choices made with regards to research approach and methods of enquiry. The research views the subject of investigation (BBI) as a dynamic digital capability that can be considered as a collection of assets, processes and performances according to an established seminal theory. Having that established the researcher views both in positivists and interpretivists epistemological world views in order to capture the knowledge base both from qualitative and quantitative means. The ontology of this research is more biased to be subjective, but objective characteristics are also manifested considering the characteristics of data collected. The research stages, data collection protocols and analysis strategies were then presented orderly. The study follows an abductive research approach, which stresses the importance of analysing multiple and interconnected levels of contexts in research design. This approach expands understanding of both theory and the empirical phenomenon under investigation by calling for sequential data collection techniques in which one aids the other. The research design is primarily three phase: preliminary framework development,

development of improved framework and knowledge/skill inventory (SKI) through the findings of the exploratory studies and finally the validation of both products. Such multidimensional construct/variable implications require mixed methodological approach and are considered to be critical for breaking the more linear view on relations between empirical data and theory development. The theoretical underpinning applied to this particular on-going PhD study would benefit up and coming researchers to gain insight on the applicability of theories practically when conducting a research.

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Appendix A

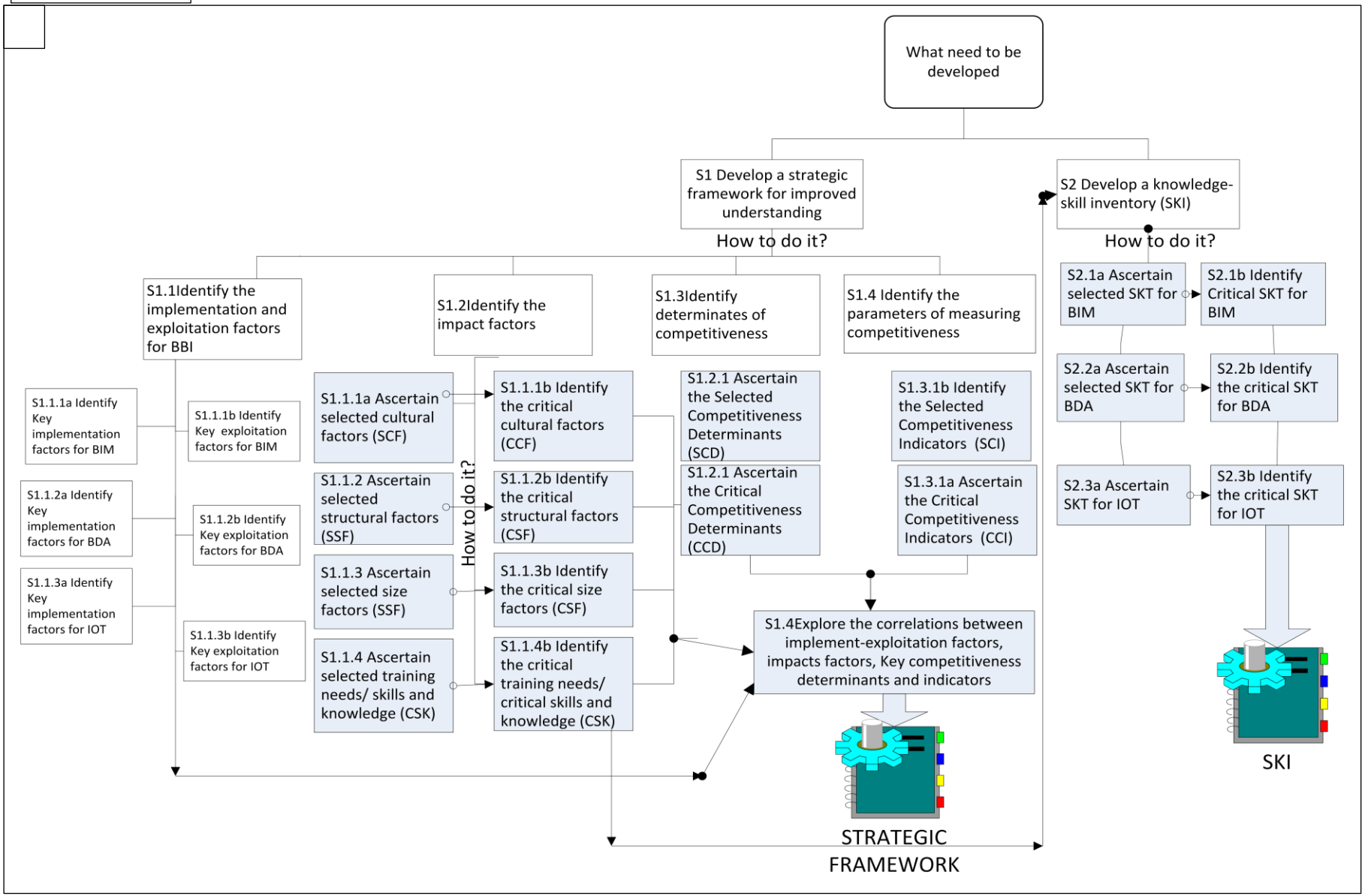


Figure 1- Research Activity diagram

Appendix B

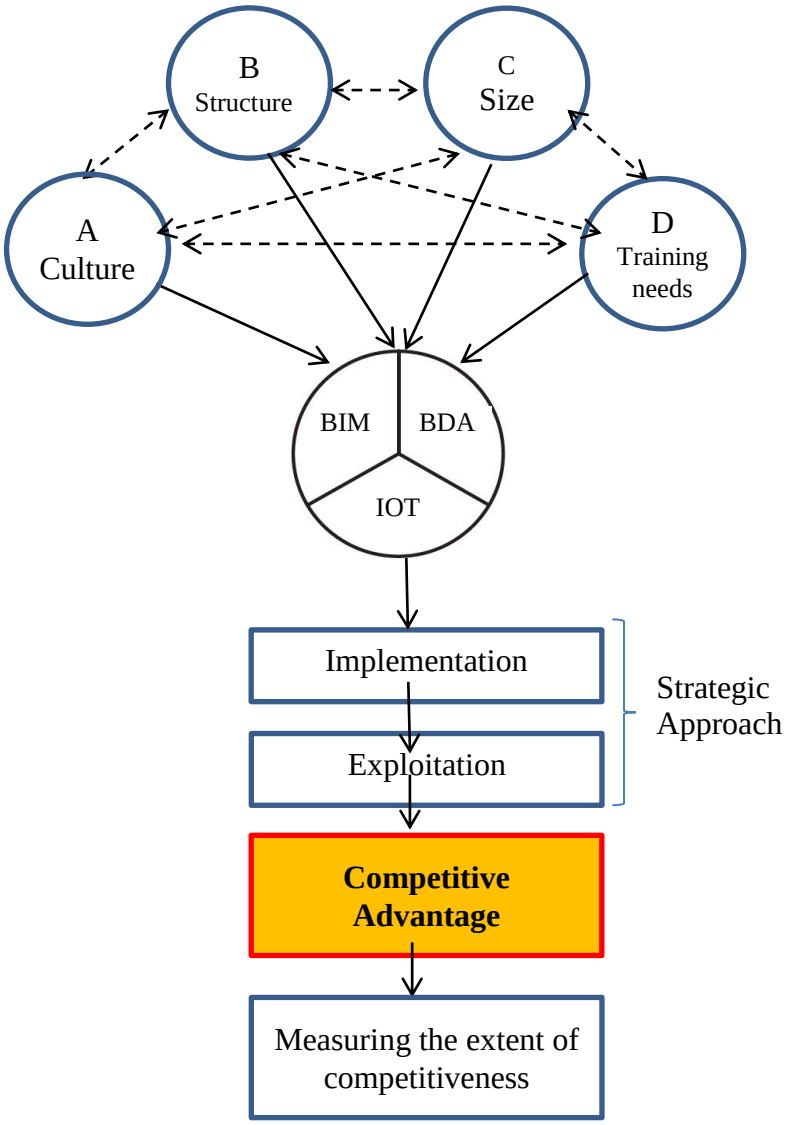


Figure 2- Conceptual Framework

# MIXED METHODS RESEARCH: A METHODOLOGY IN SOCIAL SCIENCES RESEARCH FOR THE CONSTRUCTION MANAGER.

**Danny O Clerigh Hogain**[6]

[1]*School of Natural and Built Environment, David Keir Building, Queen's University Belfast, Stranmillis Road, Belfast, BT9 5AG*

Much has been written about the differing schools of philosophy, their relationship with us and the world we live in. A research philosophy is an acceptance or a belief in the methodology in which data for a study should be collected, analysed and used. Research within the construction industry is primarily based on qualitative and quantitative methods but can include studies that combine both philosophies. As these methodologies do not study the same phenomena, they cannot, therefore be combined for cross-validation. They can however, be combined for analogous purposes. It is this key feature of mixed methods research, with its differing philosophies, which has the potential to provide high quality research. The research also explains the principles central to mixed methods research and its application to industry. In the construction industry solutions are generally based on knowledge and experience developed over many years. The research aids advancement of industry knowledge by adapting methods applied in academia, by providing a robust framework for construction managers, for designing and undertaking mixed methods research. This research demonstrates and strengthens that mixed methods research will become increasingly successful as more construction managers study, use and spread its philosophy.

Keywords: construction managers, mixed methods, qualitative research, quantitative research, research methods.

## INTRODUCTION

It may be argued that construction managers who undertake research to successfully solve the problems faced by the construction industry need to adopt a strong methodological approach, that takes into account both ontological and epistemological viewpoints. In Chapter 1 of Knight and Ruddock (2008), Andrew Dainty, in reviewing the predominant research approaches to construction, states that there is an over reliance on quantitative research in construction management, and even when qualitative research is used, it is predominantly semi-structured. Fellows and Liu (1997) echo that for many years, positivism and quantitative methods have been in the ascendancy in construction management research. Dainty (2008) further suggests that no single methodology can ever provide a complete picture and a pluralistic approach should be encouraged to link between judgment and analysis. The aim of this research is to investigate and highlight the various concepts available to a construction manager to engage fully with and properly utilise the various categories of research and methodologies available. It will differentiate between and explore the various philosophies pertaining to research methods and strategies. It will then forward the reasons for choosing the mixed methodology as the investigative approach for the

[6] docleirighohagain01@qub.ac.uk

research, by positioning mixed methods research as the natural balance to traditional qualitative and quantitative research.

### Justification of Study

Research would indicate that many construction managers tend to primarily use a quantitative form of research (Fellows and Liu 1997; Dainty 2007; Creswell and Plano Clark 2011), with the minority using a qualitative form of research. Both miss out on the advantages that the opposing paradigms can bring. Therefore, this study demonstrates that mixed methods can provide an alternative form of research, whereby results from both research paradigms can triangulate and support each other.

## LITERATURE REVIEW

### Research Strategies

Fellows and Liu (2008) define research as 'the systematic investigation into and study of materials, sources, etc. in order to establish facts and reach new conclusions'. The Economic and Social Research Council (ESRC) in 2007 defined research as 'any form of disciplined inquiry that aims to contribute to a body of knowledge or theory'. A qualitative approach looks to gather insights into and understand people's perceptions and experiences of the environment in which they operate. Qualitative research is typically carried out prior to quantitative research (Morgan 1998), as it constructs a framework upon which quantitative research can be based but this can lead to the misperception that that qualitative research is only exploratory and needs to be validated quantitatively. Quantitative methods gather factual data, investigate relationships between facts and highlight consensus between the relationships that are revealed from those previously uncovered and documented in the earlier research.

'Research is systematic, critical and self-critical enquiry which aims to contribute to the advancement of knowledge' (Bassey 1995). To be successful, the research needs to be strategized. 'Selecting an appropriate research strategy is key to ensuring that research questions are addressed in a way which has value and is congruent with the overall topic, questions and purpose of the research'(Walshe, et al. 2004). A research methodology outlines and substantiates the methods implemented for the collection, analysis and interpretation of the data. Levy (2006) states that the nature of a research problem should drive the methodology adopted. So before undertaking the research, an understanding of the underlying assumptions behind 'valid research' is essential, to justify the methodologies to be used in the research design. Justification of the methodological choice should then relate to the theoretical perception that supports the research (Crotty 1998). These issues relate to the epistemology, the enlightening of the theoretical perspective and the type of methodology that then leads to the selection of methods.

### Research Categories

Bassey (1995) differentiates three categories of research:

- Theoretical Research, where researchers aim to describe, interpret and explain events, but do not make any judgements about them
- Evaluative Research, where researchers aim to describe, interpret and explain events so that they or others will hopefully be able to evaluate and make judgements about them
- Action Research, where researchers seek to describe, interpret and explain events, then seeks to change them for the better

These can then be broken down into factions and be carried out using differing methodologies.

**Research Stages**

Research design is the subject of debate, as academics and authors disagree about the name, order and the nature of research stages. For example, Saunders, et al. (2007) classify research into six stages; Philosophical Stance, Approaches, Strategies, Choices, Time Horizons and Techniques. These formed a model which was presented as 'the research onion', as depicted in Figure 1. On the other hand, Crotty (1998) narrowed them down to be: epistemology, theoretical, perspective and methodology; methods to constitute the four primary elements of research design.

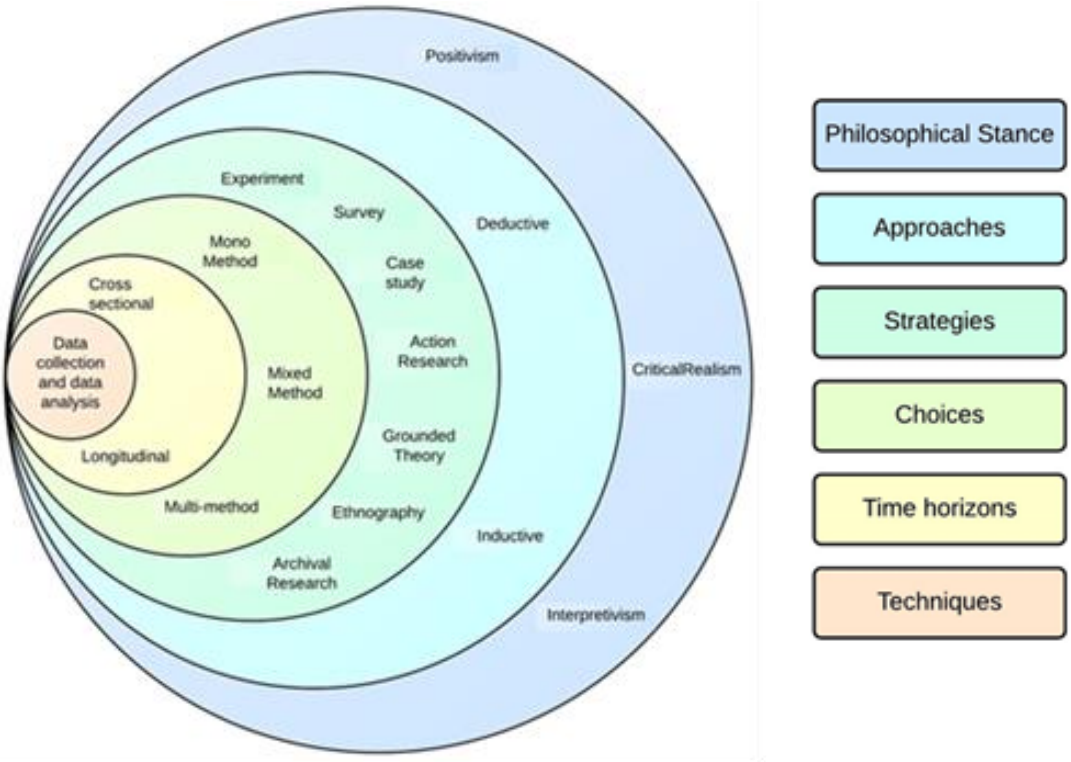


*Figure 1. The Research Onion (Adapted from Saunders, et al. 2012)*

Crotty (1998) also states that the terminology used in research literature is often confusing with epistemologies, theoretical perspectives, methodologies and methods 'thrown together in grab-bag style as if they were all comparable terms'. He goes on to suggest that these terms represent distinct hierarchical levels of decision making within the research design process. Creswell (2009), bases his research process framework on Crotty's (1998) four research design elements and suggests that these four decision making components leads to an approach for research, which inclines to be quantitative, qualitative or mixed methods.

**Research Philosophy, Paradigms, Ontology and Epistemology**

From before the times of Socrates, Plato and Aristotle, much has been written about the differing schools of philosophy, what it means to us and the world we live in. In terms of research, it is the way in which it is conducted that can be conceived of in terms of the philosophy that the research subscribes to. A research philosophy is an

acceptance in, or a belief about the manner or methodology in which the data for a study should be collected analysed and used. All research concerns knowledge, its gathering and advancement. Mertens (2003) define a paradigm as a worldview, complete with the assumptions that are associated with that view. This definition corresponds with the attitudes of several others (Lincoln 1990; Van Marren 1990; Rossman and Rallis 2003; Creswell and Plano Clark 2007). Morgan (2007) refers paradigms as 'systems of beliefs and practices that influence how researchers select both the questions they study and methods that they use to study them'. Guba (1990) defines it simply as a 'basic set of beliefs that guides action'. Scotland (2012) states that a paradigm contains each of the following components: ontology, epistemology, methodology and methods. Every paradigm is therefore based upon its own ontological and epistemological assumptions and will contain differing ontological and epistemological views; meaning they have conflicting assumptions of reality and knowledge which underpin their particular research approach. These differences will then be reflected in their methodology. Ontology derives from the Greek onto (being) and logia (written or spoken discourse). It is a branch of metaphysics, the study of first principles or the essence of things. Crotty (1998) defines ontology as the study of being, therefore, ontological assumptions are concerned with what constitutes reality, in other words 'what is'. Scotland (2012) states that researchers need to take a position regarding their perceptions of how things really are and how things really work.

Objectivist ontology view social phenomena and their meanings as existing autonomously of social actions, whereas constructivist ontology infers that social phenomena are produced through social interaction and are therefore in a constant state of revision. (Bryman and Bell 2003). Epistemology refers to knowledge and to the concept that research is expected to make a contribution to the development of knowledge. The term epistemology derives from the Greek, Episteme, science, and logos, study and is therefore the study of the scientific knowledge from a critical point of view (Toohey 1952; Cuvillier 1966; Moser 2002). Epistemology is concerned with the nature and forms of knowledge (Cohen, et al. 2007). Epistemological assumptions are concerned with how knowledge can be created, acquired and communicated, in other words what it means to know. Guba and Lincon (1994) explain that epistemology asks the question, what is the nature of the relationship between the would-be knower and what can be known? Grix (2004) argues that ontology and epistemology are to research what foundations are to a house. If so, (using the house as an analogy), Kehily (2012) states ontology may be the foundations but epistemology may very well be the rising walls, as we can only construct how knowledge is acquired (epistemology) if we build on what is out there to know (ontology). Once we understand the deeper discussion of reality, we can go about determining the nature of it. Anyone undertaking research will normally need to convincingly argue how their research contributes to knowledge in a given field (Knight and Ruddock, 2008). Epistemology deals with the nature of this knowledge and a well-founded understanding of how others in the same research field acquired their knowledge is necessary, if it is to build upon it. Epistemology (known to be true) opposed to Doxology (believed to be true) incorporates various research philosophies. Unfortunately, research is not as easy to define, but Bassey (1995) believes whilst there is no general agreement as to how research should be defined, there are three commonly agreed principles. These are that research is a process of inquiry and investigation, it is systematic and methodical, and it increases knowledge (Hussey & Hussey 1997). Two chief research philosophies are now identified with the western tradition of science, Positivist (also known as scientific) and Interpretivist (or Anti-

Positivist) (Galliers 1991). This viewpoint ignores a related philosophy, that of post positivism, one of the most common forms of post-positivism is a philosophy called critical realism.

Table 1, adapted from Carson, et al. (2001), is a summary of the main characteristics and the essential differences between positivism and interpretivism. For example, where positivism assumes a direct access to the real world and a single external reality, interpretivism does not, a method consistent with an interpretivist approach such as those taken by Levy and Schuck (1999 and 2005). Positivists assume that it is conceivable to obtain; hard, secure and objective knowledge, therefore positivist research is able to focus on generalisation and abstraction to a wider context. Interpretivists believe that an understanding of the world can only be gained through knowledge as perceived by individuals. This leaves us with the implication that any interpretivist research tries to understand and explore problems within a specific context (Levy, 2006).

*Table 1. Broad Definitions of Positivism, Interpretivism and Epistemology*

| Epistemology | Positivism | Interpretivism |
|---|---|---|
| Nature of 'being' nature of the world | Have direct access to the real world | No direct access to the real world |
| Reality | Single external reality | No single external reality |
| 'Grounds of Knowledge between reality and research | Possible to obtain hard, secure objective knowledge | Understood through 'perceived' knowledge |
| | Research focuses on generalisation and abstraction | Research focuses on the specific and concrete |
| | Thought governed by hypotheses and stated theories | Seeking to understand specific context |

## Qualitative V Quantitative Research Paradigms

Research can be either qualitative or quantitative (Fellows and Liu, 2008). A qualitative approach looks to gather insights into and understand people's perceptions and experiences of the environment in which they operate. Quantitative methods gather factual data and investigate relationships between facts and highlight consensus between the relationships that are revealed and those previously uncovered and documented in the earlier research. 'There are about as many definitions of qualitative research as there are books on the subject' (Guest, et al. 2013). This form of research refers to non-statistical methods and generally involves discussions with interviewees to gather data on particular research questions or explores a central phenomenon. A qualitative approach therefore looks to gather insights into and understand people's perceptions and experiences of the environment in which they operate (Sugarman and Sulmasy 2001; Creswell and Clark, 2011). The qualitative paradigm is based on interpretivism (Kuzel and Like 1991; Altheide and Johnson 1994; Secker, et al. 1995) and constructivism (Guba and Lincoln 1994). Ontologically speaking, there are multiple realities or truths based on one's construction of reality. Reality is socially constructed (Berger and Luckmann 1966) and so it is constantly changing. The researcher and the object of study are interactively connected, so that findings are jointly created within the framework of the situation which shapes the inquiry (Denzin and Lincoln 1994; Guba and Lincoln 1994). Although the use of qualitative studies provides persuasive, in-depth insights through subjective interpretations of

experiences, adopting mixed methods allows researchers to minimise the over-dependence on statistical data to explain a social occurrence and subjective experiences (Jogulu and Pansiri, 2011). In contrast, the quantitative paradigm is based on positivism. Science is characterized by empirical research, and all phenomena can be reduced to empirical indicators which represent the truth. Sale, et al. (2002) state that the ontological position of the quantitative paradigm is that there is only one truth, an objective reality that exists independent of human perception. Epistemologically, the researcher and the research are independent entities, therefore, the investigator can study a phenomenon without influencing or being influenced by it; 'inquiry takes place as through a one way mirror' (Guba and Lincoln 1994). The quantitative goal is to measure and analyse causal relationships between variables within a value-free framework (Denzin and Lincoln, 1994). Research tends to be written or orally administered questionnaires with a limited range of predetermined responses, with responses analysed using statistical software packages.

Table 2 highlights identified advantages and disadvantages to both positivism and interpretivism. It should be remembered that these are aligned with quantitative and qualitative research, respectively.

*Table 2. Advantages and Disadvantages of Positivism and Interpretivism*

| | **Positivism** | **Interpretivism** |
|---|---|---|
| **Advantages** | Efficient collection of a large amount of data<br>Clear theoretical focus for the research from the beginning<br>Easily to compare data<br>Easier for the researcher to retain control of the research process | Facilitates understanding of the how and why<br>Good at appreciating social processes<br>Enables researcher to be active to changes which occur<br>Allows for complexity and contextual factors |
| **Disadvantages** | Inflexible – difficult to change direction when data collection has started<br>Weak at appreciating social processes<br>May not uncover the meanings attached to social phenomena | Data collection may be time consuming<br>Data Analysis can be challenging and complex<br>Researcher has to live with the uncertainty that clear patterns may not emerge<br>May be perceived as less credible by non-researchers |

## Mixed Methods

In recent years, the use of multiple methods in research is discussed as 'mixed methods'. This is where researchers and supporters of mixed methodologies pragmatically combine qualitative and quantitative research. Teddlie and Tashakkori stated in 2009 that, mixed methods research tradition is less well known than the quantitative or qualitative traditions because it has emerged as a separate orientation during only the past 20 years. Creamer (2018), further state that the defining characteristics of mixed methods, has continued to evolve, since emerging as a methodological movement in the late 1980s and Bazeley (2018) declares that mixed methods is relatively recent , dating from the later decades of the twentieth century. There is evidence that mixed methods is being accepted as a third research approach and is becoming popular in some disciplines (Johnson et al., 2007; De Silva, 2009; Bazeley, 2018). This mixing qualitative and quantitative methods encourages interest

and debate (Greene & Caracelli, 1997; Sandelowski, 1995; Swanson, 1992). A mixed method study combines elements of qualitative and quantitative research approaches (qualitative and quantitative viewpoints, data collection and analysis techniques) in a single study, concurrently or sequentially (Johnson et al., 2007; Creswell et al., 2008; Borrego et al., 2009).

Mixed methods have become an alternative, simply by promoting the use of those methodological tools that answer the research questions under study. In fact, during the 20th century, social and behavioural scientists repeatedly employed mixed methods in their studies and continue to do so (Greene, et al. 1989; Maxwell and Loomis 2003; Brewer and Hunter 2006). As supporters of mixed-method research argue, the complexity of human phenomena needs more complex research designs to capture them (Sandelowski 2000). Several definitions exist for mixed methods research. Greene, et al. (1989) define mixed methods research designs as those that include at least one quantitative method and one qualitative method. Burke Johnson and Onwuegbuzie (2004) indicate that mixed methods research is the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study, a definition supported by the Journal of Mixed Methods Research, who state it is 'research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry' (Tashakkori and Creswell 2007). This is furthered by Creswell and Plano Clark (2007, 2011) who, whilst sidestepping the issue of paradigms, characterise mixed methods as having a set of guiding philosophical assumptions whereby qualitative and quantitative strands meet in the study and it is this combination that that provides a deeper understanding than either approach used alone. Several viewpoints and arguments have emerged as to why qualitative and quantitative methods can and should be combined. Haase and Myers (1988) claim the combination is possible because they share the objective of understanding the world in which we live. King, et al. (1994) claim that both qualitative and quantitative research share a unified logic and that the same rules of inference apply to both. Reichardt and Rallis (1994) take this further by stating they are unified by a shared commitment to understanding and improving the human condition, a common goal of disseminating knowledge for practical use and a shared commitment for rigor, conscientiousness and critique in the research process. So closely aligned are the; objectives, goals and commitments. Casebeer and Verhoef (1997) state qualitative and quantitative methods should be viewed as part of a continuum of research with specific techniques selected based on the research objective. Others such as Clarke and Yaros (1988), Steckler, et al. (1992) and Baum (1995) highlight that in some research areas with complex phenomena, requiring data from a large number of perspectives demand the use of a broad spectrum of qualitative and quantitative methods. Abowitz and Toole (2010) advocate a mixed methodology by stating that the combination of quantitative and qualitative approaches in research design and data collection should be considered whenever possible. They go on to say that this advances the validity and reliability of the resulting data and strengthens causal inferences by providing the opportunity to observe data convergence or divergence in hypothesis testing, an argument supported and furthered by Niglas (2004), who states that if researchers were to use several different methods for investigating the phenomenon of our interest and the results provide mutual confirmation, then, we can be more confident that our results are valid. Johnson and Onwuegbuzie (2004) support this by stating that Mixed Methods research should draw from the strengths and minimise the weaknesses of both, in

single research studies and across studies but not altogether replace either of these approaches. They further state that, philosophically it is the 'third wave' or third research movement, one that moves past the 'paradigm war' because it offers a rational and practical alternative. Bryman et al. (2008) proposes that the use of mixed methods through the combination of different data sources helps uncover different views, perceptions and experiences. Howe (1988) forwards an interesting argument by suggesting that researchers should forge ahead with what works. Truth, he states, is a normative concept, like good and truth is what works. Creswell (2009) ventures there are more insights to be gained from the combination of both qualitative and quantitative research than either form by itself. Their combined use provides an expanded understanding of research problems.

However, some researchers believe that mixed methods are incompatible. They argue that qualitative and quantitative methodologies are drawn from different epistemological assumptions and have different research cultures that are contra to the merging of research methodologies (Sale *et al.*, 2002; Brannen, 2005; Scott and Briggs, 2009). In addition, the use of mixed methods research present challenges to the researcher. Bryman (2008) cautions that there is a risk that it may now be seen as an each way bet.

Table 3 demonstrates that there are disadvantages to a mixed methodology that need to be overcome. One interesting disadvantage or barrier to the promotion of mixed methods identified by Molina Azorín and Cameron (2010) is related to the challenges of publishing mixed methods studies, arising from existing constraints such as; word and page limits in journals.

*Table 3. Advantages and Disadvantages of Mixed Methods*

| **Mixed Methods** | |
|---|---|
| **Advantages** | **Disadvantages** |
| Strengths offset the weaknesses of both quantitative and qualitative research | Research design may be very complex |
| Pluralist methodology provides a more complete and comprehensive understanding of the research problem than a singular methodology | Requires longer time span and resources to plan and implement |
| Increases the ability to generalise the results | May be difficult to plan and implement one method by drawing on the findings of another |
| Helps to explain findings or how causal processes work | May be difficult to resolve discrepancies that arise in the interpretation of the findings |
| Provides an approach for developing better, more context specific instruments | More costly in terms of; time, money and energy |
| More comprehensive research | Researcher has to learn about multiple methods and approaches |
| Answers a broader range of research questions | Increased workload for researcher |
| Words, pictures, and narrative can be used to add meaning to numbers | Can be difficult for a single researcher, especially when the two approaches are used concurrently |
| Can answer a broader and more complete range of research questions | Difficult when used in a single study |
| Robust evidence provided for a conclusion through convergence and corroboration of findings | |

Source: (Bazeley, 2004; Creswell, 2003, 2009; Creswell and Plano Clark, 2007, 2011; De Silva 2009; Johnson and Onwuegbuzie, 2004; Teddlie and Tashakkori, 2009)

## CONCLUSION AND RECOMMENDATIONS

It is perhaps time for construction managers to recognize that a third paradigm exists and it is there to be utilized. Whilst there are disadvantages these can be overcome by the researcher, it may be the case that they have to develop a new mixed methods design, because no one best design exists for their research project but as Teddlie and Tashakkori (2009) highlight, mixed methods design has an opportunistic nature. Consequently, in many cases, a mixed methods research project may have a predetermined research design but new elements in the design may evolve as the research progress and reacts to new discoveries. The researcher, therefore, needs to be creative and not be limited by the existing designs. Many authors, Creswell, Teddlie and Tashakkori, Flick, Burke Johnson and Onwuegbuzie, Crotty, Dainty, Fellows and Liu all put forward recommendations for designing, implementing and reporting a mixed methods study. They recommend that researchers pay regard to design and implementation issues, particularly to how and when data is collected. The purpose of the research will have a bearing on this. It may be that the researcher or construction manager is familiar with one paradigm only but learning a new method and adopting a pluralistic approach will be rewarded with, triangulated, validated and reliable results.

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# THE PROBLEM OF DEMAND IN AFFORDABLE HOUSING

**Neema Opiyo[7] and Paul Chan**

*University of Manchester*

The need for affordable housing has in recent times become a prominent policy issue across the world. Among various challenges to affordable housing sector is the failure of supply to keep up with this growing demand. Consequently, it is unsurprising to find a wealth of studies that focus on supply-side concerns of accommodating increasing demand for affordable housing. Such studies have tended to emphasize the roles played by providers such as developers, contractors and government institutions to improve capacity and capability in the production of affordable housing. However, such emphasis results in the relative neglect on the demand side. In this review, we consider the problem of 'demand' to identify fresh perspectives on understanding the challenges associated with affordable housing. Through literature review, we lay open the complexities of studying 'demand' by drawing a range of disciplines. From an economic perspective, 'demand' is often framed in quantitative terms where balancing supply and demand results from rational, technological choices made by individual actors in the marketplace. Yet, such a linear approach to 'demand' runs counter to a sociological understanding, where the realization of 'demand' is produced by (and in turn produces) complexes of social practices. Indeed, taking a linguistic turn, the etymology of 'demand' stems from the Latin phrase de mandare, which means 'to formally order'. Thus, 'demand' is not simply defined by exogenous forces of the market, but also raises questions as to how society is brought to order. In the context of affordable housing, understanding 'demand' also raises the need to examine ways in which vulnerable segments of society are excluded from formally ordering their requirements. In this review, we will reflect on various perspectives of 'demand' to raise questions about power relations and the problem of building a more inclusive society through housing.

Keywords: Affordable Housing, Demand, Methods, Review

[7] neema.opiyo@postgrad.manchester.ac.uk

## INTRODUCTION

Globally, affordable housing has become a policy priority and topic of considerable research interest. Despite a wealth of research into affordable housing, insufficient supply which cannot keep up with the demand remain a perennial problem (Gabriel et al., 2005; Mulliner and Maliene, 2011; Gan et al., 2017). The worldwide demand for affordable housing has grown in recent decades and is expected to continue to grow each year (Wallbaum et al., 2012; Schwartz, 2013). Furthermore, the problem of poor housing affordability is becoming more acute in many cities and housing is, for many people, their major expenditure and critically affects the quality of life (Ezebilo, 2017). The recent economic and foreclosure crises have led to a tight housing market that makes it difficult for the vast majority of households to meet their housing needs especially those in the weaker economic band. This raises the question of how the increased demand can be accommodated and tacked (Makinde et al., 2014).

It is unsurprising that a review of literature has indicated a comprehensive and growing devotion on the supply side concerns of affordable housing while little attention is given to demand side. These studies tend to address the work of provider/ developers, government, and community at large perform can and should do to improve capacity of affordable housing production and financing (Nguyen, 2005; Goetz, 2008; Tighe, 2010; Tighe, 2012; Albright et al., 2013; Nguyen et al., 2013; Davison et al., 2016). Milligan et al. (2004) reviewed potential policies and strategies that would support an expansion and diversification of affordable housing models in Australia. On the one hand scholars have paid attention to the planning system as an alternative solution to shortage of housing supply(Paris, 2007; Whitehead, 2007; Gurran, 2008; Austin et al., 2014; Gurran and Bramley, 2017) while on the other hand, commentators have placed more weight on how to tackle opposition, NIMBYISM and negative connotation of affordable housing in order to promote its supply (Goetz, 2008; Tighe, 2012; Albright et al., 2013; Nguyen et al., 2013; Davison et al., 2017). Other attempts to attract increase private developers' interest in the supply of affordable housing are also discussed in the literature. The use of low income housing tax credit in the US and application of section 106 in the planning section in the UK are in place to stimulate production of affordable housing from private developers which in the end will assist both renters and home buyers (Cohen, 1997; Oakley, 2008; Sidawi, 2009; Walter et al., 2017). Such emphasis on supply side subsidies meant that policies have often neglected the demand side and the possibilities of direct subsidies to tenants. By demand side we mean end-users or householders. There is a gap in knowledge between requirement for housing and the ability to obtain the preferred housing type, which result in an effective request crisis for affordable housing.

Against this backdrop, this paper revisits research on demand for affordable housing in an attempt to offer fresh insights into the methods and different ways on which we can study demand. Literature on interpretation of demand from multiple perspectives is reconsidered with a view to inject fresh perspectives of the problem especially to the low income earner and contribute to the literature on demand for affordable housing.

This paper is organised as follows: section one provides an overview of the meaning of affordable housing and point at significant reliance on income vs housing expenditure to define it. Section two will introduce the demand concept and provide and multiple perspective of demand in various non-housing studies. The critical

perspectives are discussed which call for the need to place greater emphasis on demand side approaches. The last section synthesis the materials collected in all section in relation to demand and affordable housing. We lay open the complexities of studying 'demand' by drawing a range of disciplines. From an economic perspective, 'demand' is often framed in quantitative terms where balancing supply and demand results from rational, technological choices made by individual actors in the marketplace. Yet, such a linear relationship does not appear to be so lined.

## WHAT IS MEANT BY AFFORDABLE HOUSING?

Before looking into details of the demand side, a question which needs to be addressed is what is meant by affordable housing? Despite almost daily reference in the media, research and policy documents to the need for more affordable housing, there is a little agreement about what this actually means. Whitehead (2007) Explain a normative view that housing is a particularly important good which should be treated preferentially as compared to other necessities because it facilitates them. According to Whitehead (2007) affordable housing at the most general level could be fairly defined as a decent home for all families a price within their means). However, this leave some of the question unanswered like what it means by decent, family and within their means. It is also silent about location and housing tenure (Mulliner and Maliene, 2013). Ram and Needham (2016) take a view that affordable housing is that which is in reasonable standard that is affordable to people on modest or low incomes. It includes various kinds of housing provision each with its own eligibility criterial for meeting different needs and collectively forms a housing continuum. The UK government explain affordable housing as social rented, affordable rented and intermediate housing provided to certain household whose need are not met by the market (Mulliner and Maliene, 2013). However this definition does not make any reference to the household income or earning that is to be spent on housing and so is often challenged for that.

Making a comparison between household income and housing expenditure is the frequently a common way to define affordable housing. It emanates from the Department of Housing and Urban Development (HUD) and is a reflection of the ability of a household to meet the cost of shelter, including rent or mortgage and utilities. HUD considers a house is affordable if households spend no more than 30% of their disposable annual income on housing cost (Nguyen, 2005; Stone, 2006). Again there are number of critics on this approach such as being broad and failure to reflect on personal preferences when it comes to choosing a house and for not taking into account location and housing qualities (Mulliner and Maliene, 2011; Jana et al., 2016).

Various working definitions of affordable housing have been attempted by others (Field, 1997; Chaplin and Freeman, 1999; Stone, 2006) but there is no wider generally applicable definition since the term "affordable housing" might mean different things to different policy arena. The general original intention of affordable housing is to meet the needs of households whose income is insufficient to access appropriate housing in the market without any assistance or intervention. It is therefore fairly to say that, affordable housing is not meant for everyone.

## Antecedents of studying demand

The term demand has a number of quite different meanings, depending on the context. Smith, (1951) stress this by stating that demand has meant many things to many people and many things to same personal. He adds that demand is in most cases used as a quantitative statement to the forces that operate on the buyer's side of a market. The oxford dictionary indicates demand can be used as authoritative requirement, a need actively expressing itself or the manifestation of a desire on the part of the consumers, client or employer for a particular commodity (Oxford English Dictionary online). In this paper, different interpretations of demand are drawn from a variety of disciplines including economics, sociology, and linguistics.

In the next sections, the economic, sociology and linguistic concept of demand is explained in relation to the use in Affordable housing debate.

## DEMAND: MULTIPLE PERSPECTIVES

### Economics

In economics, demand and supply are terms which are perhaps one of the most fundamental concepts and the strength of market economy. The terms supply and demand refer to the behaviour of buyers and sellers of a particular good or service. Together, buyers and sellers form the market for the particular commodity. The concept is best clarified in most elementary textbooks of economics. As an example and reference, "Essentials of economics" by Harvard economist Gregory Mankiw (2009) is used. Demand carries a broader meaning of undertaking utility. It takes one of four classes of meaning which are quantity demanded, the demand price, their product (amount spent or to be spent on the commodity) or demand schedule which represent the relationship between demand price and the quantity demanded. Demand shows the users or buyers' need and ability to obtain a certain product or service (Ball and Seidman, 2011; Joffe, 2017). The quantity demanded is the amount of goods buyer is willing and able to purchase depending on various factors. The price of a product or service serves a particular importance as it makes market works. The affordability (ability of customer to pay) makes demand effective and so plays a crucial part (Mankiw, 2009). In simple or loose term, demand represents what people want and their purchasing power.

- In economic world the trade-off that consumers make between available goods and services when allocating scarce resources of time and money is very important and makes it very critical to be addressed (Garber-Yonts, 2005). There is an assumption that during purchase, consumers makes sensible, rationale choices of utility maximization which is originated from Narasimhan work, 1984 (Parsa and Njite, 2008). Demand theory assumes that end-user only decide to spend their money on things that brings them most happiness at the minimum costs. As the consumer is thought to be the most important focal point, understanding how and why they makes decision to purchase certain product cannot be overlooked. Moreover, taking such a rational view implies that sellers and buyers can exercise their freedom in the context of a free market. In the context of affordable housing, where those who demand such commodity are often vulnerable

segments of the population who live on the margins of society, this freedom is questionable.

It is also well established that not everyone can afford certain type of products that they desire due to a wide distribution of disposable income in the society which creates different purchasing power. Those with high purchasing power have more power on demand and may afford most of the high price goods and luxury one. It is a different story to those on weak economic segment who often are vulnerable and marginalized as demand is a matter of desire and affordability. Most households may be considered ineffective in demand simply because they do not possess the power to acquire their needs and automatically excluded from the housing market. This also affects what is being produced as it mostly reflects those with high purchasing power in power relation (Joffe, 2017).

### Sociology

Sociological perspective of demand is centred on the theory of social practice in which demand is produced and reproduced by complexes of normal social practices. Demand of resources such as energy is curtailed in the practices of those who use it as it is an outcome of what people do. Consumption of these resources is an outcome of what they do in everyday life like showering and travelling any people are the carrier of these social practices. Any change to these practices would result to the change of demand for the particular resources. Understanding the relevance of social practice aid understanding demand for instance for affordable housing in this case (Shove et al., 2015) and will contribute to the ways problems of demand are tacked. Demand of such resources is stimulated not for their own sake but as a way of accomplishing social practices (Shove and Walker, 2014; Shove et al., 2015). Again demand is shaped by material infrastructures and institutional arrangements. Shove provide example of energy and explain that consumption of energy cover systems of provision and supply. Since demand is a result of social practice, instead of focusing on "taking effective actions" as a means to tackle scarce resources like energy, focusing on practice might provide a more reliable and sustainable approach to a chronic problem of demand. In Shove and Walker (2014)'worlds, both demand and supply are realized through artefacts and infrastructures that constitute and that are in turn woven into bundles and complexes of social practice. The common contention is that societies are in part defined by the way in which resources are organised and managed (Shove and Walker, 2014). This is a similar case with the housing. Houses are not important in a standalone scenario. They are important due to what they are for, for instance as a means to provide a home which then offer comfort, rest, privacy and safety (Ellsworth-Krebs et al., 2015). The need for such things increases demand for housing.

### Linguistic

Indeed, taking a linguistic turn, the etymological roots of the term demand comes from the Latin words -de- meaning formally and –mandare- which means to order. Taking all together, demand can imply to formally order. This means that demand is not simply defined by exogenous forces of the market in the economic lenses but raises question as to how society is brought to order and being able to formally placing a request or making an inquiry of things that matters to them.

Understanding demand raises the need to examine ways in which vulnerable segments of people in the society may be excluded from formally ordering their requirements through social accounts like housing. By vulnerable we mean those people in the society who are in need of special care, support or protection because of their status, age, disability and they are therefore exposed to the possibility and risk of being attacked, abused or harmed or neglected either physically or emotionally. These households may include for instance Elderly people, people with mental illness, children, young people, disabilities, homeless, refugees and minorities who in most cases are of low income. Lack of affordable housing can be seen as threat to social order (demand).

**DEMAND IN AFFORDABLE BOUSING CONTEXT**

Affordable housing is not an isolated challenge as it affects other aspects of life such as economics, psychological and social (Schwartz, 2016). Housing demand is the number of dwelling units that are actually needed by the people at a particular point in time, while housing supply is the number of residential units that are provided by the key players in the accommodation provision (Makinde et al., 2014). Whitehead (2007) discusses that in practice, in what is clearly a very suboptimal world, neither demand nor supply properly reflect real resource costs and there are therefore many potential opportunities for modifying both demand and supply to improve outcomes. Whitehead (2007) recommends modifying demand by either reducing net incomes or decreasing relative price of housing to address affordability. Another way is by reducing real resource costs of producing housing e.g. by technological change or by making supply more elastic and lastly by liberating the regulatory system to ensure more land for affordable housing is available. However, (Gurran and Bramley, 2017) challenge this by arguing that building more houses unit may probably not be sustainable solution, so is price control not the answer to affordable housing. There is therefore a need for more research to realise potential solution to the problem of affordable housing.

Literature has enormous evidence on how low income households are faced with the problem of affordability. They are the first group that spend more than 30 percent of their income on housing and trade-off other basic needs for their daily life (Mulroy and Ewalt, 1996; Hamidi et al., 2016). This segment fails to formally order both housing and non-housing requirements. According to HUD, severely cost burden households spend more than 50% of their income on housing cost and face acute affordability stress. It is not surprisingly, low income households are more likely to fall victim to the pressures of housing costs burdens and as a results they are forced to make a difficult trade-offs in other social aspects like health and financial stability, food and clothing, transport and retirement saving ( Hsu, Jenny, 2016) as housing is an asset so expectations matter (Barker, 2003)

As it can be well agreed that the lower the income, the lower chances of the family to own a car and therefore they largely depends on public transport (Welch, 2013). Since they cannot formally make a request on socially acceptable standard house in a potentially good location, they are forced to live in the outskirt and spending more time and money in transport to work and in search of other social services (Fisher et al., 2009). It can be argued that, in order to bring the society to order, the demand side of affordable housing needs to be looked in critical lenses.

From the sociological point of view it can be inferred that demand for affordable housing is increasing due to changes in some social practices for instance getting

marriage and home formation. One would argue that, currently it is very easy to be single especially in the western world by either not formally or informally getting married. Baker (2003) consent that change in demographic formation characterised by single family households, increased divorce, improved life span and general population increase translate to extra accommodation need hence increased demand for affordable housing. This work is by no means suggesting that getting married or more weddings will resolve the affordable housing crisis, yet it only tries to point out issues which need serious consideration in the planning and execution of affordable housing that reflect the current and future need of their expected households.

Certainly, taking the economic view of demand, low income and vulnerable households are excluded from the effective demand as they only have desire for better and affordable housing but lack purchasing power which is fundamental in the transaction. People of low status might have less power of claim to available housing when they are in high demand than do people of high status. It is important to examine the differential impact of these conditions, the actual power over access to house should minimize overload and allow one to conduct desired activities with less interference while less power would lead to more interruption and inability to conduct preferred activities. consideration of social position per se, the interaction between low social power and the attitude of powerlessness in conjunction with crowding should be carefully studied (Baldassare, 1978).

## CONCLUSION

The purpose of this review is to critically evaluate past approaches and recent developments in demand. All we are trying to argue here is the problem of affordable housing is rooted from the problem of demand; how we conceptualize define and interpret demand. Shifting our focus on the demand will results into production and supply of affordable housing which targets the needs of the households which means that even the few available housing units will shows magnificent results in the housing sector particularly in affordable housing and disadvantage groups.

In the view of what demand is from different perspective, it might not be of essence to neglect the end user (demand side) as Smith (1952) stresses that consumption is the sole end and purpose of all production and the interest of the producer out to be attended to only so far as it may be necessary for promoting that of the consumer. While the government and policy maker's concerns is to increase supply and quality of affordable housing in the market and keeping its cost at minimal, developers on the other hand want to increase their investment return and earn more profit. Yet, residents and neighbours, desire homes that showcase their lifestyle, aspiration and affordability which should be the focus of our policy and practices (Scally and Tighe, 2015; Gan et al., 2017).

The review has shown how placing our focus on demand and the way is understood would raise really interesting questions. We normally think of end users on the demand side but the question is who really speaks for the end-users. Do those who demand affordable housing really have a voice, and how is that voice exercised?

Taking from behavioural, social practice and the need to formally put society to order, some interesting question on demand for affordable housing are raised. Exposing demand through these multiple, cross-disciplinary ways brings to the fore a number of

under-examined areas that would be the future target and developmental aspect of this paper concept wise and methodological. These include:

1. The supply and demand of affordable housing is not just a question of quantity, but also a question of quality of that housing. To this end, there is a lack of studies on how requirements for quality of affordable housing are co-produced with the end-users. This is despite growing recognition of the importance of co-production of knowledge between service providers and service users.

2. From an epistemological standpoint, a re-focus on demand for affordable housing also raises the question of how we (researchers, industry stakeholders, policy-makers and practitioners) can access the needs of vulnerable populations. Oftentimes, these segments are hard-to-access because of they are relative invisibility to the mainstream. Giving these vulnerable populations voice, and more crucially, getting the voice heard and listened by those who supply affordable housing remains a methodological challenge.

3. Based on this review, understanding demand for affordable housing goes beyond a techno-rational approach often driven by quantitative and economic judgements. There is a need to lay open the understanding of demand by studying the social practices and institutional arrangements that condition and constrain the provision of affordable housing.

4. Demand may favour innovation and innovation creates extra demands (Kleinknecht and Verspagen, 1990). That may imply that increased demand should attract more innovation in housing sector to bring about changes required in the industry that will contribute to the sustainable solution to housing crisis and especially affordable housing. With this increased demand for housing, where are our innovative ideas to tackle the demand? Edler and Georghiou (2007) ascertain that when public demand is oriented in innovative solutions and products, it has a potential to improve service delivery and public policy which will result to improved innovative dynamics and benefits from associated spill overs. We argue that housing is also a form of social and public demand which should attract more innovation and be improved through demand side approaches.

5. Affordability can be improved by shifting our foci into the demand side (users) and improvement of purchasing power of the poor vulnerable households (Quigley and Raphael, 2004). Still, with limited supply, policy to improve demand may produce less fruits.

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# DEVELOPING A BIM-KNOWLEDGE (BIM-K) FRAMEWORK FOR IMPROVED DECISION MAKING IN CONSTRUCTION PROJECTS: A SEQUENTIAL EXPLORATORY APPROACH

**Ganiyu, Sikiru Abiodun[8] and Charles Egbu**

*London South Bank University*

Implementation of building information modelling (BIM) on construction projects is increasingly gaining global acceptance as government from various countries are becoming the driving force for its adoption. The UK government, for example, gave a directive in 2011 mandating the adoption of BIM on all centrally procured public sector projects, with effect from 2016. This is because BIM is believed to have the capacity to address some of the challenges facing the construction industry through effective stakeholders' collaboration and efficient information management throughout the project lifecycle. Despite the promised benefits of BIM, the current BIM approach has been criticised for being information-centred and not matured enough to generate and capture experiential knowledge, just as knowledge management (KM) is said to be a stand-alone process separated from BIM implementation. The purpose of this paper is to present the research methodology to be adopted for this research; given the aim and the objectives of the research, a set of research questions were proposed for the research. This paper discussed the various research philosophical positions and approaches available to all researchers, and positions this research on one considered to be most suitable to achieve the stated aim and objectives of the study. The paper summaries the review of extant literature on knowledge management (KM) and BIM implementation. The paper concluded by proposing a preliminary framework for integrating experiential knowledge to BIM implementation and a KM process cycle that can facilitate the integration.

**Keywords**: axiology, BIM-infused knowledge, epistemology, mixed method, sequential exploratory approach.

[8]ganiyusikiru@gmail.com

## INTRODUCTION

Implementation of building information modelling (BIM) on construction projects is increasingly gaining global acceptance as government from various countries are becoming the driving force for its adoption. The UK government, for example, gave a directive in 2011 mandating the adoption of BIM on all centrally procured public sector projects effective from 2016. This is because BIM is believed to have the capacity to address some of the challenges facing the construction industry through effective stakeholders' collaboration and efficient information management throughout the project lifecycle. Despite the promised benefits of BIM, the current BIM approach has been criticised for being information-centred and not mature enough to generate and capture knowledge, just as knowledge management (KM) is said to be a stand-alone process separated from BIM implementation. This research is therefore, meant to provide an answer to a fundamental question: 'In what complex ways can the integration of knowledge to BIM improve its implementation for impactful decision making in construction projects?' Based on pragmatic paradigm, the study adopts sequential exploratory mixed methods approach. This approach will involve the collection of both qualitative and quantitative data using purposefully selected projects as case studies. After stating the aim, objectives and research questions of the study, the remaining sections of the paper provides an overview of the research methodology, research philosophy and approach for the study, and a summary of the review of extant literature on knowledge management and BIM implementation. The paper concludes by proposing a preliminary framework for the integration of experiential knowledge into BIM implementation and KM process cycle to facilitate the integration.

## RESEARCH AIM

The aim of this research is to develop a "BIM-Knowledge" (BIM-K) Framework that will integrate experiential Knowledge into BIM implementation for improved decision making in Sustainability of Construction Projects.

## RESEARCH OBJECTIVES

The objectives of the research are:

i. to investigate how knowledge management can help address the challenges of BIM implementation to enable sustainability in construction projects;
ii. to explore the experiential knowledge required for BIM implementation to achieve sustainability in construction projects through investigation of the decision-making process;
iii. to outline a knowledge management process that enhances integration of required knowledge to BIM implementation for enabling improved decision making in sustainability of construction projects;
iv. to identify the key factors that impact on the effectiveness of the outlined knowledge management processes;

v. to develop a conceptual BIM-Knowledge framework that enables the identification, acquisition and application of the knowledge required for integration into BIM implementation to enable sustainability in construction projects; and
vi. to develop a skill and knowledge inventory (SKI) of key decision makers to enable the practical use of the framework.

## RESEARCH QUESTIONS

This research seeks to provide answers to these questions:

i. How can knowledge management help address the challenges of BIM implementation to enable sustainability in construction projects?
ii. In what complex ways can knowledge be integrated into the implementation of BIM for improved decision making to achieve sustainability in construction projects?
iii. How can knowledge management process be used to enhance integration of experiential knowledge into BIM implementation for decision making?
iv. What factors impact on effectiveness of the knowledge management process for the integration of experiential knowledge into BIM implementation?
v. What skills and knowledge are required by the key decision makers in the use of BIM-infused knowledge Framework?

## RESEARCH METHODOLODY

Based on the nature of the research problem and the aim of the research, this study will adopt a mixed method to explore how best to integrate experiential knowledge into BIM implementation for improved decision-making. The researcher will explore all available resources to get an in-depth understanding of the problems, through the use of pluralistic approaches to extract knowledge in a bid to address the research problem. Therefore, the researcher will not be limited to a single system of reality. Mixed methods give the liberty to combine data collection and analysis methods from both qualitative and quantitative approaches to form a continuum. Hence, a sequential exploratory mixed method will be adopted to drive both in-depth understanding of the subject matter and generalise findings using a two-way research process (Creswell, 2014).

The research began with a comprehensive review of extant literature on knowledge management (KM) and BIM implementation. This review of literature on KM focused on KM applications in the construction industry, with a view to identify the current KM processes adopted in the industry as well as to highlight some of its benefits that can be adapted to BIM environment. The literature review on current approaches to BIM implementation was undertaken to reveal the challenges of implementing BIM, which justified the need for better integration of experiential knowledge into BIM implementation to achieve continuous improvement in decision-making. Based on the findings from the review of literature, a preliminary conceptual framework for

integration of experiential knowledge into BIM implementation and KM processes map for determining required knowledge for BIM implementation will be developed.

Thereafter, some of the centrally procured public BIM-enabled projects in UK will be selected and the key decision makers (middle-level managers) involved in the projects will be invited to participate in focus group interviews (FGIs). This is with a view to explore their understanding of how best to effectively capture and integrate their experience-based knowledge into BIM implementation for enabling continuous learning and improvement in decision-making in future projects. They will also be required to identify those factors that impact on the effectiveness of the KM processes for integration and the required skills and knowledge required for the usage of the integration framework. Focus group interviews (FGIs) is suggested instead of individual interviews as a qualitative data collection method to enable participants, who usually work together as a team, to build on others' responses (Neuman, 2009), corroborate what others have said with their own personal experiences, and provide an in-depth exploration of a wide range of perspectives within a short period of time (Gray, 2009). Based on the suggestion of Polkinghorne (1989) that participants of FGIs should not exceed 25, four (4) middle level managers usually involved in the decision-making in BIM implementation, from six (6) selected projects will be involved in FGIs. These middle level managers will include: Project Manager, Design Team Manager, Construction Manager, and BIM (information/knowledge) Manager. With the permission of the participants, the discussions of the FGIs will be recorded and later transcribed for data analyses using NVivo.

Drawing on the reviewed literature and findings from the FGIs, the list of factors compiled will be put together in a questionnaire survey which will be administered on general BIM practitioners to confirm wider applicability and generalisability. The respondents of the questionnaire will be asked to indicate the degree of importance of factors that impact on the effectiveness of the outlined knowledge management process and to rank the list of skills and knowledge required of key decision makers in the use of the BIM-Knowledge framework. The research population for the questionnaire will consist of all the BIM practitioners/professionals in the UK. The questionnaire survey will be administered through both online platform and at conferences. For online distribution, sites such as BIM Task Group, BIM+ website, RIBA website, RICS LinkedIn, CIOB website, etc. will be employed. The data from the responses will be analysed using Statistical Package for Social Sciences (SPSS) software.

Based on the empirical findings from the analyses of the FGIs and the questionnaire survey, the preliminary framework will be reviewed, upgraded and refined. The results of the analyses will also be used to develop the skills and knowledge inventory (SKI) required by the key decision-maker for the practical usage of the framework. The refined BIM-Knowledge framework and the SKI will be validated through a focus group discussion (FGD).

## RESEARCH PHILOSOPHY AND APPROACH

This section of the paper discusses the research philosophy and approach for this study. It investigates the various research philosophies and approaches with a view to identifying the most appropriate one for the study, given the research aim and objectives set for the study.

A paradigm is a description of the method for collecting and explaining the knowledge of a phenomenon (Saunders et al., 2012). It refers to 'worldview, together

with the various philosophical assumptions associated with that point of view' (Teddlie & Tashkkori, 2009). A worldview consists of philosophical stances, comprising ontology, epistemology, axiology and methodology (Hall, 2013). There are four generally agreed paradigms from the literature (Hall, 2013) that can be adopted by a researcher as a worldview. These are: positivism, constructivism, transformative and pragmatism. Based on the aim of this research, the researcher will adopt pragmatism as his world-view. Pragmatism is simply a practical way of solving a problem; it is closely associated with mixed methods research (Cameron, 2011). According to Feilze (2009), pragmatism essentially concerns itself with solving practical problem in the 'real world'. The reason for adopting pragmatic paradigm is to allow the research questions to decide which research philosophy will be most appropriate to address them, since pragmatism allows the use of more than one means to collect and analyse the data in other to solve a research problem (Meesapawong et al., 2014).

Philosophy deals with the source, nature and development of knowledge (Bajpai, 2011). In the layer of 'research onion' (figure 1), the research philosophy is positioned at the outer layer such that it will be the first topic to be clarified in research methodology. The philosophical stand of this study, arising from the pragmatic paradigm already taken, shall be discussed under its ontology, epistemology and axiology.

Ontology is the philosophical position about the nature of reality and the existence of the entities (Easterby-Smith et al., 2012; Saunders et al., 2012). While Saunders et al. (2009) divide ontology into two: objectivism and subjectivism, Oppong (2014) identified three types of ontological perception of reality as: realism, idealism and critical realism. This research aligns itself with Oppong classification for its flexibility and adopts critical realism (CR) as its ontological philosophical stance. This stand is in line with the pragmatic paradigm which seeks to combine explanation and interpretation. Archer et al. (2016) describe critical realism as 'a meta-theoretical position: a reflexive philosophical stance concerned with providing a philosophically informed account of science and social science, which can in turn inform our empirical investigation.' Critical realism presents itself as an alternative paradigm to scientist form of positivism which concerns itself with regularities and regression-based variable models, in one hand, and the strong interpretivist or postmodern turn which denied explanation in favour of interpretation, and focus on hermeneutics and description at the expense of causation, on the other hand (Archer et al., 2016).

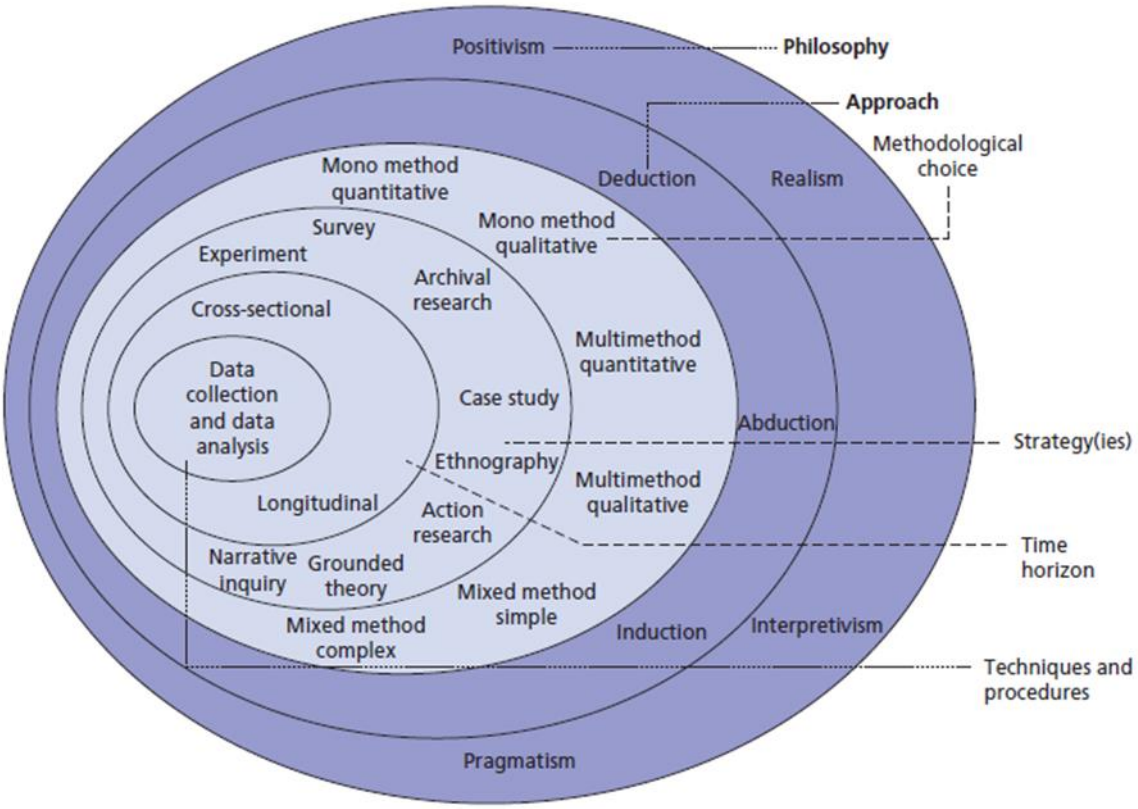


Figure 1: The Research Onion. (Source: Saunders et al., 2012)

Epistemology, on the hand, focuses on what constitute valid knowledge and how such knowledge can be obtained. It is about the most appropriate ways of enquiring into the nature of the world (Easterby-Smith et al., 2012). According to Oppong (2014), knowledge can be seen from the positivist position in which knowledge is viewed as objective, or from interpretivist position which holds that reality can never be objectively observed outside. The third epistemological position, according to Oppong (2014), is epistemic relativism which believes that knowledge can be articulated from various points of view depending on various influences and interests. To truly know the reality, knowledge must therefore be situated within a particular social-context or historical-perspective. Hence, the epistemological position of this research is relativism because of its social embeddedness.

Axiology is the aspect of research philosophy that focuses on the place of value in research process. In line with the three prominent paradigms, Oppong (2014) also identified three positions associated with axiology thus: 1. Science must be value-free; 2. It is not possible to eliminate value from any part of science; and 3. Value is not only inevitable, but a desirable aspect of the research process. In line with critical realism adopted for this study, the axiological position of this research is that it will be rational in its value.

Regardless of research area, it is important to discuss the research approach and situate one's research within the available approaches with a valid justification for the adopted approach. There are three research approaches that can be found in the literature. These are: Deductive research approach, Inductive research approach, and Abductive research approach. Deductive approach is usually used to test the validity of assumptions (or hypotheses) (Wilson, 2010; Snieder & Larner, 2009) while inductive approach is used to contribute to the development of new theories and

generalisations (Goddard & Melville, 2004). Abductive research approach is set to make up for the weaknesses associated with deductive and inductive approaches by adopting a pragmatist perspective. According to Saunders et al. (2012), deductive approach is criticized for lack of clarity on how to select theory to be tested via formulating hypotheses, while inductive approach is criticized based on the fact that no amount of empirical data will allow for theory-building. The research process in this case is devoted to explanation of 'incomplete observation', 'surprising facts' or 'puzzles' that were specified at the beginning of the study using qualitative and quantitative research methods of data collection and data analysis in an integrated manner (Bryman & Bell, 2015). This research will adopt the abductive research approach because it will best address the research aim and objectives, and it is in tandem with the research paradigm and philosophical stance already adopted. It will also allow for the development of the framework that will allow for the integration of experience-based knowledge to BIM implementation through the exploration of these phenomena. The research philosophy and approach discussed above can be summarised in the table 1.

Table 1: Summary of Research Philosophy and Approach

| **Research Paradigm** (What is your worldview?) | **Ontology** (What is reality?) | **Epistemology** (How is reality known?) | **Axiology** (What is the value of the reality?) | **Research Approach** |
|---|---|---|---|---|
| Positivism | Empiricism (There is only single reality) | Objectivism (Reality can be objectively measured) | Value-free | Deductive |
| Constructivism | Interpretivism (There is no single reality; but multiple realities) | Subjectivism (Reality is subjective; it is socially constructed) | Value-laden | Inductive |
| **Pragmatism** | **Critical Realism** (Reality is constantly negotiated) | **Relativism** (Reality is relative; best method solved the problem) | **Rationality** (Value-bound) | **Abductive** |

## LITERATURE SUMMARY ON BUILDING INFORMATION MODELLING AND KNOWLEDGE MANAGEMENT.

Building information modelling (BIM) is fast replacing the traditional ways of designing, building and operating facilities by more streamlined and collaborative work process, heavily supported by data-rich, parametric software applications (Niemeijer 2015). HM Government (2015) document of Digital Built Britain defines Building Information Modelling as "a collaborative way of working, underpinned by the digital technologies which unlock more efficient methods of designing, creating and maintaining built assets". BIM is defined by the National BIM Standard as "a digital representation of physical and functional characteristics of a facility", and it is a "shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition" (BSA 2012). BIM is characterised by its ability to create, and operate on shared digital database for information exchange. It enables capturing and preserving

information for reuse as well as managing changes effectively, such that a change to a part of the database is automatically reflected to all other parts (Autodesk 2002). However, as stated by Boyles (2016) the current focus of BIM practices is on digital data management and information exchanges with little consideration and exploitation of experience-based knowledge.

Knowledge has been recognised as a critical resource, not only for delivering project successfully, but also making decisions that impact on the overall lifecycle of a project. There is an increased awareness on the value and importance of experience-based knowledge of project workers for organisational competitiveness and improvement. The type of tacit knowledge which usually resides in the head and mind of the owners has been argued to be most valuable, and the need to capture them for use and reuse has been recognised for improving decision-making and continuous learning. Knowledge management is about planning, organizing, motivating and controlling individuals and organisational information systems to improve their knowledge assets and productivity (King 2007). Knowledge management (KM) can help focusing the organisation on generating, capturing, storing and utilising knowledge for problem solving, dynamic learning, strategic planning and decision-making (Charlesraj 2014). Since the main goal of KM is to improve productivity and team-work through knowledge creation and knowledge communication platform, it is imperative, therefore, to explore a KM approach that can help generate, capture and integrate experiential knowledge into BIM for improving decision-making during design and construction processes using BIM platform.

## PRELIMINARY FRAMEWORK FOR INTEGRATING KNOWLEDGE INTO BIM IMPLEMENTATION.

Arising from comprehensive review of the literature on KM and BIM implementation, a preliminary framework is proposed on how to generate required experiential knowledge for integration in BIM implementation based on identified KM processes. The identified KM processes for this framework are: Knowledge Identification, Knowledge Generation, Knowledge Codification, Knowledge Communication, Knowledge Application, and Knowledge Evaluation (Figure 2). The proposed integration framework is then mapped on the identified KM processes. Though both RIBA Plan of Work (2013) and UK Government Digital Plan are in agreement with the PAS 1192 Level of Detail in terms of number of stages involved in lifecycle of a project, however, the proposed framework compressed the stages for BIM implementation from eight to six for purpose of brevity and clarity. Deconstruction stage was particularly emphasized to demystify the belief that a project must necessarily be demolished at the ‘end of use’. Hence, the framework recognises six stages as project lifecycle for BIM implementation.

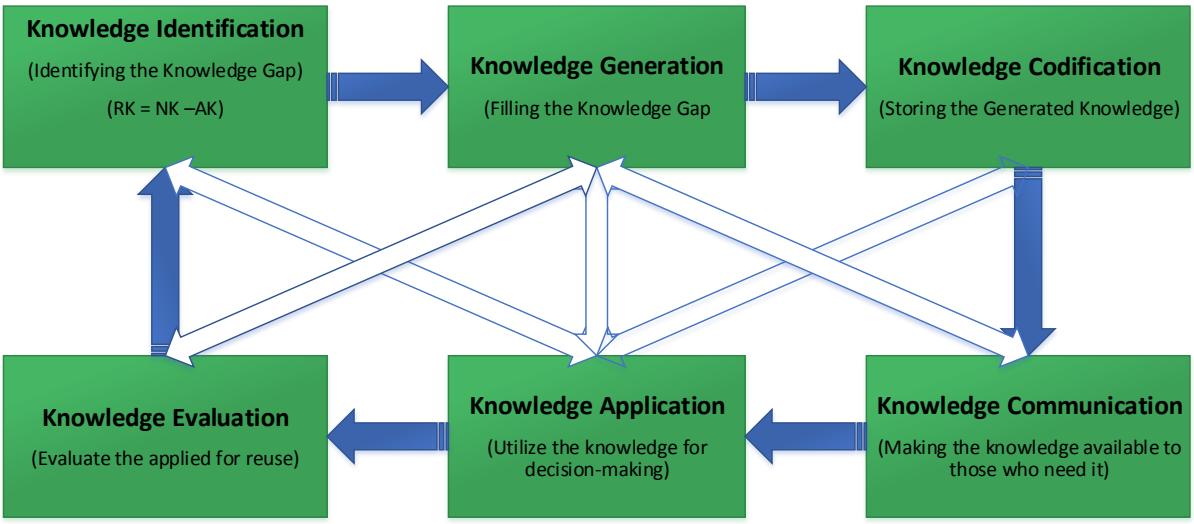


Figure 2: Knowledge Management Process Cycle for the Integration.

The preliminary framework hypothesized that at the beginning of a project, the BIM goal(s) for the project is clearly defined and project brief taken. To effectively identify the required knowledge and generate it for integration, the organisation starts by determining the required knowledge for achieving the project BIM goal. This is done by identifying the knowledge gap between the necessary knowledge and the available knowledge within the organisation. It has been argued that both tacit and explicit knowledge are required for effective decision-making for project delivery. Given the fact that the existing BIM approach operates as shared digital database for information exchange (explicit knowledge), the required knowledge that needs to be generated, captured and integrated into BIM practice is the experiential (tacit) knowledge of the experts, especially on how they manage the information components of the current BIM for improved decision-making in other stages of the project and other future projects. The experience-based knowledge is then generated and/or acquired through appropriate KM instruments such as brainstorming The knowledge is taken through the all the six stages of KM processes and the evaluated knowledge, including the lessons learned are ultimately integrated back to the organisation BIM database inform of explicit knowledge for reuse in other stage of the project or future projects.

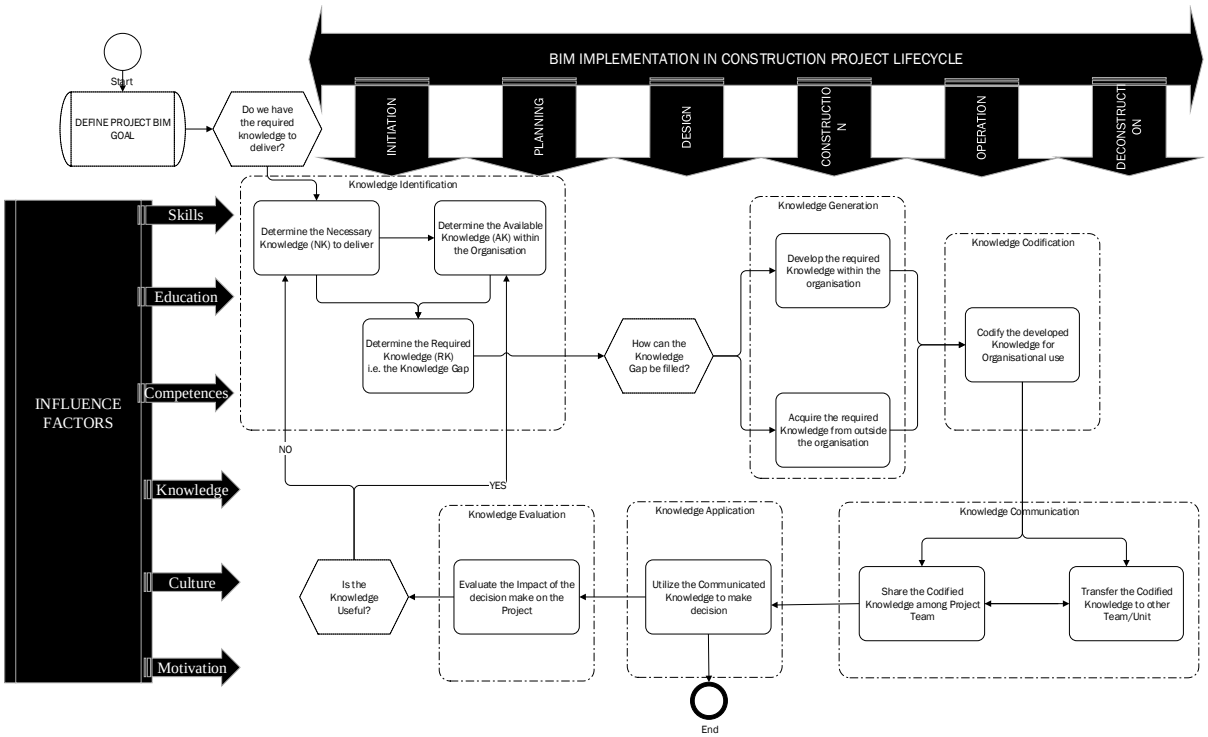


Figure 3: Preliminary Framework for Integrating Experiential Knowledge into BIM Implementation.

## CONCLUSION

The need to develop a framework for integrating experiential knowledge into BIM implementation for improved decision making is the focus of this study. To achieve this aim, the researcher has chosen an exploratory sequential mixed methods approach. The paper presents the details of this methodology, its research philosophy and approach, and attempts to justify why the method is most appropriate for the study, given the research aim and objectives. The research adopts pragmatism as its paradigm, critical realism as its ontological position, relativism as its epistemological stand, and is thus value-bound. Based on this philosophical world view, the researcher adopts an abductive research approach. After a summary of the review of literature, a preliminary framework for integration of experience-based knowledge into BIM implementation is developed based on six processes of knowledge management. The preliminary framework will be further developed and validated after empirical data collection using the proposed research methodology presented in this paper.

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